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THE

MALAYAN AGRICULTURAL JOURNAL

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Kuala Lumpur.

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THE

Malayan Agricultural Journal

APRIL, 1953.

EDITORIAL

Mechanical Cultivation and Harvesting of Wet Padi in Malaya.

This issue of the Journal, publication of which has been unavoidably delayed, contains the third general review of the investigations into the mechanical cultivation and harvesting of wet padi which have been in progress since 1947. This third review pays particular attention to the investigations into harvesting the crop by mechanical means—the operation which, in Malaya, has presented the biggest obstacle to complete mechanisation of the tasks involved in producing rice. Much progress has been made and investigations have been continued in the present season.

While discussing the subject of rice-growing in Malayan, attention is called to the figures on page 139 of this issue which show that at the end of April 95 per cent. of the wet padi planted during the 1952-53 season had been harvested at an estimated average yield per acre of 349 gantangs (gallons). It is estimated that 409,900 tons of rice would have been produced by the end of April, 78,700 tons more than was produced from the total wet padi crop in the 1951-52 season.

Blister Blight of Tea.

A third article by Mr. Johnston, the Acting Senior Plant Pathologist, on the disease Blister Blight appears on page 81. In this article Mr. Johnston records the results obtained from some further spraying experiments.

Mention was made in the October, 1951, issue of this Journal of the expense incurred in spraying tea bushes with fungicides to control blister blight. These latest experiments by Mr. Johnston have, in the main, aimed at discovering ways in which the cost of spraying can be reduced while control of the disease is maintained. To this end Mr. Johnston has been successful in that he was able to control the disease while increasing the interval between sprayings or by reducing the strength of fungicide by half.

The experiments confirmed the superiority of copper fungicides over other materials.

Cockchafer Pests of Cacao. In the third article in this issue of the Journal, Mr. Lever, the Entomologist, describes the cockchafers which do damage to the leaves of cacao to an extent that may prevent the successful establishment of the trees in the field. These beetles feed only at night and lie buried in the soil during the hours of daylight. They feed on the leaves of trees of all ages but damage to young trees is the most severe, especially if they have been planted in the open with little overhead cover. Attacks on young trees can be checked by erecting a guard of palm fronds or similar material around the tree until it is about one year old.

In one particular area of newly planted cacao a soil population count was taken in April and May, 1952, and sampling indicated a population of 43,000 per acre, grubs being more numerous in soil between trees and adults beneath the trees.

Mr. Lever recommends benzene hexachloride as the best insecticide for killing larvae and adults in the soil, and lead arsenate for use as a foliage spray.

A REVIEW OF INVESTIGATIONS INTO THE MECHANICAL CULTIVATION AND HARVESTING OF WET PADI WITH SPECIAL REFERENCE TO THE LATTER

BY

E. F. ALLEN,

Senior Agronomist,

and

D. W. M. HAYNES,

Agricultural Engineer.

Introduction.

Investigations into the mechanical cultivation of wet padi have been in progress in the Federation of Malaya since 1947 and two general reviews have already been published, (11) and (16). This paper brings these reviews up to date.

At the expense of some repetition it is necessary to define clearly the purpose of mechanisation of wet padi cultivation. This has already been clearly stated (19) :—

" (i) it may allow the introduction of new methods of cultivation which will increase the yield of padi,

(ii) it may allow the work of cultivation and preparing the seed bed to be so hastened that there is a sufficiently long off-season available for a second crop to be taken or, if an off-season crop is already taken, to lengthen its growing season sufficiently for its yield to be appreciably increased."

" (iii) it can lighten the work of the smallholder. In so far as this encouraged him to look after his padi better and so get higher yields, this would almost fall in the first group, and in so far as it encouraged him to grow better off-season crops, it would almost fall in the second group. In so far as it did neither of these things, it would have to be justified on political grounds,.....".

There is a fourth reason:—

(iv) it may allow padi to be cultivated in potential areas where, for one reason or another, existing population is insufficient to provide for peak labour requirements at cultivation and harvest.

In the case of a pilot scheme to be opened up in an under-populated area, full mechanisation of all operations is essential. Furthermore, if that area is under swamp jungle, the problems of mechanised clearing of that jungle must also be capable of solution.

These considerations are dealt with more specifically in a later section.

Ecological Considerations.

Existing and potential padi areas are shown in the accompanying map. They may be classified according to climate and soil type:—

Region	Climatic Zone	Soil Type	Cultivation
Kedah-Perlis.	N-E Monsoonal.	Coastal Alluvium.	By plough.
North-East Coast.	N-E Monsoonal.	Coastal Alluvium.	By plough.
Port Dickson-Malacca.	S-W Monsoonal.	Coastal Alluvium.	By plough.
Rest of Country.	Equatorial.	Coastal Alluvium.	
		(a) Bog soils.	By hand.
		(b) Clays.	By hand.
		(c) Sandy clays and loams.	Mostly by plough.
		Inland Alluvium.	
		(a) Bog soils.	By hand.
		(b) Clays and loams.	Free-drained areas by plough, the rest by hand.

Regional average rainfall is shown in Graph I.

The world's chief grain belt lies outside equatorial regions and it is generally true to say that the more seasonal the climate the better suited it is for cereal cultivation. It is self-evident, therefore, that, as Malaya lies within the equatorial region, the country's best padi areas lie to the north in the Kedah-Perlis and North-East Coast regions. It was natural that the greatest development should take place in these areas and it follows that a large proportion of the present crop is cultivated north of latitude 4° 30′ N. In consequence it is precisely in these two favourable regions, where mechanisation should be relatively easy, that negligible areas of potential padi land now exist.

In the equatorial region an exhaustive attempt has been made to introduce mechanisation to the bog soils of Perak (1), (2), (3). This was finally abandoned in favour of first attempting such mechanisation in an area presenting less difficult problems (19). Accordingly, emphasis has been placed on investigations within the "hard-pan" zones of the coastal and inland alluvial areas. Much less work has been done on the coastal alluvial clays derived from mangrove swamps where cultivation is mainly carried out by a short chopping scythe or *tajak*.

Soils-Water Relationships.

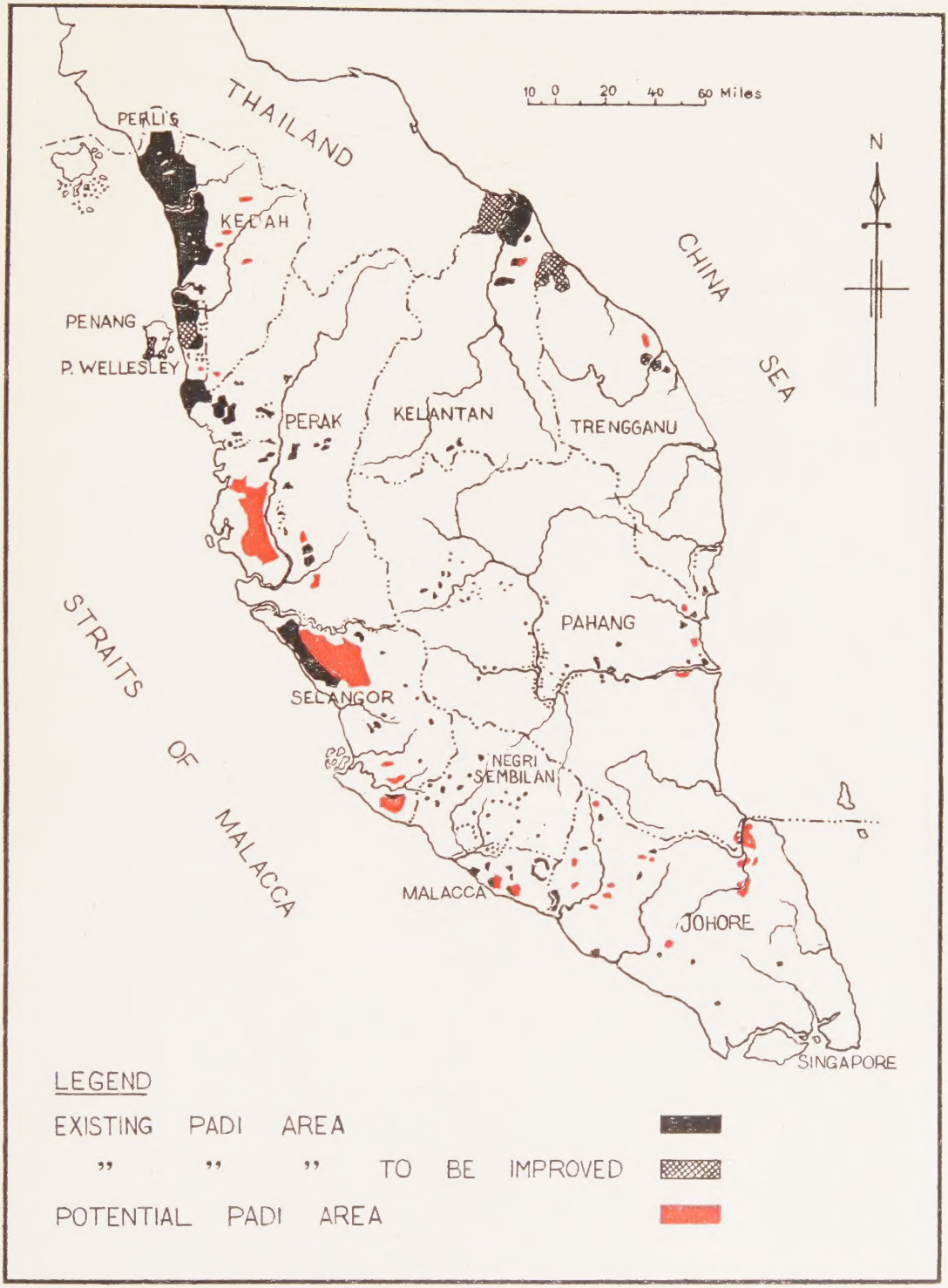
The soils-water relationships of padi land in the cultivation season are of considerable importance as they influence both the type of machine and implement and also the timing of cultivations.

On soils with a hard pan there are the following possibilities:—

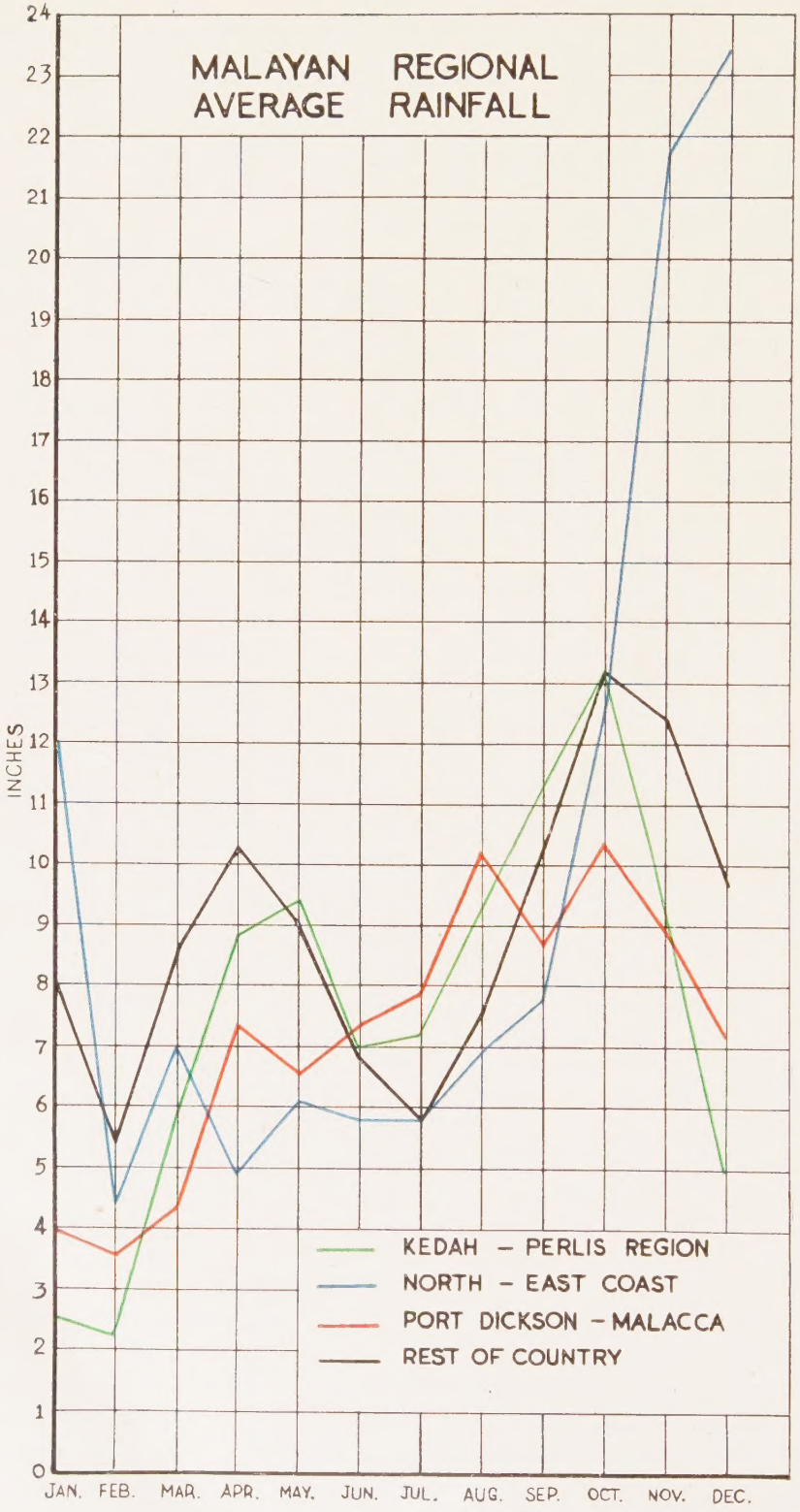
(i) Dry cultivation followed by drilling or seeding in dry soil with subsequent irrigation.

EXISTING AND POTENTIAL PADI AREAS

IN THE FEDERATION OF MALAYA.



Graph I.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OCT.
NOV.
DEC.
KEDAH – PERLIS REGION
NORTH – EAST COAST
PORT DICKSON – MALACCA
REST OF COUNTRY

(ii) Dry cultivation followed by flooding and transplanting as usual.
(iii) Wet cultivation followed by normal transplanting.
(iv) Dry cultivation followed by flooding and seeding in shallow water.

The first three cultivation methods have been tested in field-trials and it has been shown (8) that the third type of cultivation gave far higher yields in Kelantan than the other two methods. In Province Wellesley it has been shown (13) that the fourth method will also give good results provided that accurate water-control is possible.

On the so-called 'bottomless" soils which are normally cultivated by *tajak* it is certain that only dry cultivation is possible and it has been found that success depends on the use of low bearing-pressure tractors and of considerable luck with the fickle Malayan weather. Since these soils usually have a high water-table in the cultivation season it is clear that tractor operation becomes progressively more difficult after completion of the first cultivation. For this reason an implement such as a tractor-mounted or tractor-drawn rotary hoe, which produces a tilth in one operation, has advantages over conventional ploughs and harrows. Furthermore, the fact that moisture is available just below the depth of cultivation means that the season for dry cultivation is restricted to six weeks at the most. If cultivations are carried out earlier, off-season growth will regenerate in the moist seed-bed before the arrival of water can prevent germination of weed seeds.

Preparation of Padi Land.

Very satisfactory progress has been made on the hard-pan soils, particularly in Province Wellesley and Kelantan (8), (12), (13). Since deep cultivation has been shown to offer no advantage over shallow cultivation the ideal implement for the first operation has usually been a mounted two-furrow or three-furrow mould-board plough with semi-digger bodies. After-cultivation with the soil wet is best carried out by a double or triple Kedah roll of a weight and size suited to the particular tractor.

The requirement of a mounted plough has restricted choice to wheeled tractors, since mounted implements for the Department's track-tractors are not yet available. However, a wide-gauge track-tractor may be of value under certain conditions for rolling or for de-bogging other tractors.

In recent trials improved performance with standard wheeled tractors has been obtained by fitting either larger diameter rear wheels or by using outsize "rice" tyres on standard size wheels. Another very valuable aid to traction has been the use of Darvill wheel strakes as these can be brought into operation very easily and they do not have to be removed for road travel.

An even more recent development is the use of Bombardier half-tracks on a standard Ferguson TE-A tractor. These half-tracks are re-

markably simple to fit and, although at present somewhat expensive, they have shown great promise under difficult conditions.

On the bottomless clay soils very little has been achieved but a new implement became available with the arrival of a Cuthbertson "Water-Buffalo" soft-land tractor in June, 1952. Early trials have already been described (4) : the tractor behaved well but no suitable matching implement could be found for the particular test conditions.

Recently a very promising prototype "Roto-Plough" has been developed in Perak by a commercial firm working in collaboration with the Rural and Industrial Development Authority and the State Agricultural Officer. This implement is, in effect, a mounted harrow-plough with power-driven discs and its performance has shown very great promise. It is considered that a larger modified version of this implement could be mounted on the Cuthbertson "Water-Buffalo" and the combination should be able to tackle wet cultivation under very difficult conditions.

Seeding or Planting.

Because of erratic rainfall in Malaya and of limited water control in many areas drilling has not been found to be an effective seeding method for wet padi although it fits in well with mechanised cultivation of dry padi. Drilling is an operation which must be carried out on dry, well-tilled, level land (10) which is free from stumps or buried timbers.

Some limited attention has been paid to the evolution of a mechanical transplanter but very little real progress has been made. A prototype design submitted to the Department from a British source has been examined in detail and reported on critically, but no early development can be expected. More recently, moderately favourable reports have been received on an Italian machine but it is evident that this is still in the prototype stage and no transplanters are likely to be available for trial in the near future (5).

The old-fashioned, fiddle type of hand broadcaster has given quite promising results with germinated seed in Province Wellesley (14), and it is evident that this particular operation will not prevent the complete mechanisation of wet padi cultivation. However, until the method has been used successfully on large acreages it will be necessary to cultivate nurseries for possible hand transplanting in the event of failure of a broadcast crop.

Wherever broadcasting by fiddle succeeds on a small scale so also will broadcasting from aircraft succeed on a larger scale. This is a standard method of seeding in California, and aircraft availability will also help to solve problems of weed-control and fertiliser top-dressing.

Weeding The Growing Crop.

This operation can be achieved or avoided by the following methods:—

(i) Thorough pre-planting cultivations.

(ii) Off-season cultivation with a dry-land crop.

(iii) Complete water control.

(iv) The use of selective herbicides.

The first method cannot always be relied on because of vagaries of weather and machines. The second method is not possible everywhere in Malaya, either because of lack of rain in the monsoonal regions or because of an excess elsewhere. The third method is the ideal but it is relatively ineffective against many swamp weeds in a broadcast crop, although it can be remarkably efficient in a transplanted padi field. There remains the use of herbicides based on 2,4-D or M.C.P.A. Commercial dusts based on the latter hormone have been applied to padi successfully using a portable, engine-driven knapsack duster (14). However, such dusts are relatively less efficient than liquid sprays and neither are effective against sedges and many swamp-grasses. A prototype pontoon-mounted sprayer has been developed but proved unsuccessful as it was found impossible to combine the light weight required for shallow draft with adequate strength to give rigidity when handling the sprayer out of water. More recently an adjustable boom has been fitted to a light-weight, pressure-retaining knapsack sprayer but this has not yet been tested on a growing crop.

In North America very extensive areas of padi are regularly treated with herbicide using fixed-wing aircraft. Some field research has recently been carried out on this technique but it is evident that the danger of drift to other crops is excessive, so air-spraying will be limited to very large padi areas where no other crop is grown. There remains the possibility of using a helicopter for this work, and the technique has been fully studied in the United Kingdom (18). However, early application is unlikely in Malaya, partly because no servicing facilities exist for civilian work but also because of the high capital and running cost of this type of aircraft.

Application of Fertilisers.

Evidence from experiments now in progress suggests that, where fertilisers give a response in yield, the phosphorus and potassium fertilisers are best applied before planting or before the final cultivation, whereas most of the nitrogen is best applied as a top dressing, either by broadcasting or by placement in the wet soil. It is clear that the first application can readily be mechanised using standard manure distributors, but the nitrogen top-dressing will probably have to be applied by hand. Application in pellet form from the air is perhaps feasible but is unlikely to be economic except on a very extensive scale. A pelleting machine has recently become available and field research is planned.

Irrigation Control.

The ability to withdraw water or to put it on the land at will is normally considered essential for mechanised padi cultivation. However, in the north Kedah plain water withdrawal without a pump is normally impossible in the growing season since the whole plain is virtually uni-

formly flooded. Further south, in the equatorial region, irrigation control varies within wide limits: on some hard pan soils water-control can be very flexible; on most of the bottomless areas the clays and bog soils are so permeable that localized water control is much more limited. This physical character of old mangrove soils requires some emphasis as it is not generally realized that irrigation water during the growing season forms a continuous phase downwards into the soil and that the whole land surface may move up and down with the flow and ebb of tides. Under such conditions it would be unreasonable to expect the degree of water control that obtains on inland soils with a puddled pan.

Harvesting Operations.

Harvesting by mechanical means at present forms a serious obstacle and until its associated problems are approaching solution it will not be possible to embark on a mechanisation pilot scheme in an underpopulated area. Even if, for some reason, complete mechanisation cannot be achieved it will still be necessary to mechanise some harvesting operations in the Kedah-Perlis region because of the peak labour requirements at that time (15). This peak occurs not so much because the man-time requirement per acre is high but because uniform planting and the sudden onset of dry weather lead to such uniformity of ripening that any delay in reaping results in considerable losses from shattering.

Conventional harvesting methods in different parts of the Federation have been described in some detail (6). In the more important padi-growing areas a sickle is used to reap the crop, leaving a stubble some 2 ft. tall. The sheaves are laid on this stubble to dry and are then threshed by hand against a short, ladder-like rack which is laid at an angle inside a large wooden tub around which is placed a Pandanus-fibre mat. The mixture of grain, chaff, broken straw and dirt which rapidly accumulates in the tub is then winnowed in the wind by dropping it from a height on to a fibre mat or else by repeatedly tossing it up into the air with a pointed basket-tray known as a *nyiru*.

The labour requirements for harvest as compared with those for other operations are shown in Table I. These figures are taken from the records of a Kelantan cultivation experiment (8) and may be considered somewhat generous in that all operations were carried out more thoroughly than in commercial practice. They are based on buffalo cultivation, hand transplanting and weeding, and hand harvest by sickle. The harvest figures are broken down in Table II to indicate the relative requirements of reaping, threshing and—for the 1949-50 season only—winnowing. It will be seen that the mechanisation of either cutting or threshing would greatly ease the peak labour requirements at harvest and that where full mechanisation is not required it might be wasteful to attempt to use a combine-harvester. Nevertheless the use of this implement may well be essential in a pilot scheme located in an underpopulated area. It has always been realized that no one set of harvesting equipment will be suitable for all conditions and for this reason several different combinations have been tested.

Table I.

Labour Required for Padi Cultivation, in Man-Hours Per Acre.

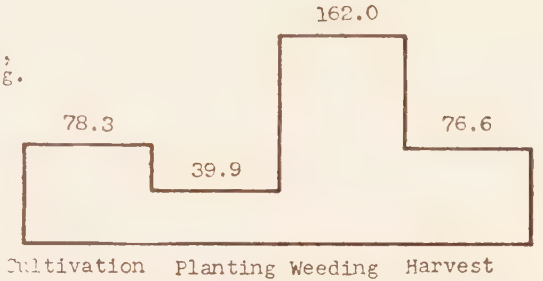
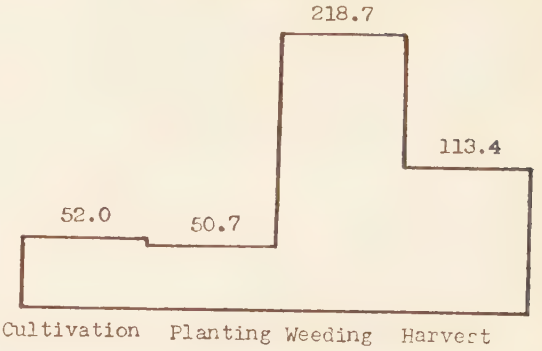
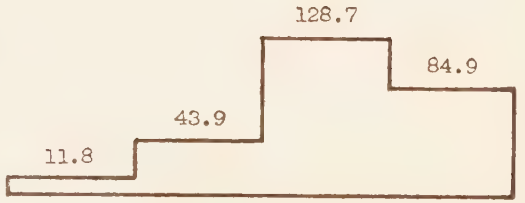
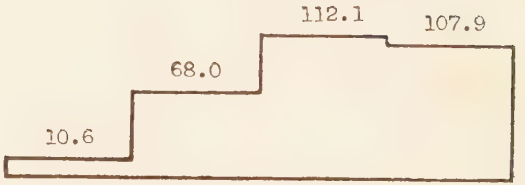
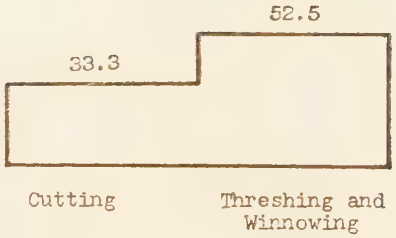
Method	1948-49 Season Yield 3342 lbs/acre	1949-50 Season Yield 1968 lbs/acre
Normal buffalo cultivation, hand-weeding and harvesting.		
Mechanical cultivation at normal time. Hand Weeding and harvesting.		

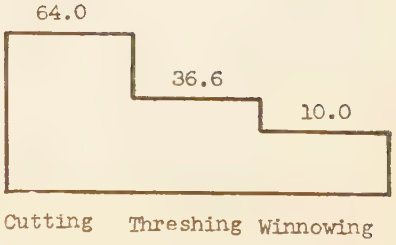
Table II.

Labour Required for Padi Harvesting by Hand, in Man Hours Per Acre.

Season	1948-49	1949-50
Yield	2780 lbs/acre	1994 lbs/acre

Labour Requirement





Padi Varieties for Mechanical Harvesting.

Since mechanical reaping is non-selective it is most important that the variety of padi grown should ripen evenly and should not shatter too easily. It should also have a stiff, short straw which is not liable to lodge. Experiments carried out in Kedah in 1939 have assessed the threshing quality of different padi varieties (20) and similar records are available from more recent trials. These data are summarized for comparison in Table III.

Table III.
Threshing Quality Assessments.

Threshing Quality.	Kedah Trials.	Other Trials.
Most easy to thresh	Mayang Ebos 80	Siam 29
	Radin China 17	Seraup Besar
	Siam 29	Reyong 6
	Mayang Ebos 88	Mayang Sa' batil
	Nachin 10	Serendah Kuning
	Reyong 6	
Least easy to thresh	Mayang Tekai	Padang Trengganu

Harvesting and Threshing Tests.

Reaping with Conventional Cutter Bars.

In the 1947 to 1949 seasons many experiments were carried out with tractor-drawn and self-propelled cutter bars with a reciprocating action. The implements used were a Tullos trailer-mower, modified to increase the maximum cutting height, a Lloyd Autoscythe and Autosickle, and Allen motor scythes.

With all these machines, cutting the crop presented no great difficulty but the resulting tangled swathe proved very troublesome to deal with since much hand-work was required to arrange it in sheaves for normal threshing.

A Model 25A Allen motor scythe was tested in Province Wellesley in the 1949-50 season (13). It was found to be comparatively easy to handle but considerable hand labour was still required to sort out the swathe and bind it into sheaves for threshing. Since no satisfactory solution could be found to this problem further work on cutter bars was suspended.

Reaper Binder Trials.

A McCormick Deering No. 3 Rice Binder was imported from America in late 1948 and given a short trial at Pulau Gadong in Malacca (17), where it was found to be somewhat slow and easily choked. It

was then sent to Chenderong Balai in Perak for testing on bog soils. Extensive modifications were necessary to reduce its bearing pressure (2) but even so it bogged down frequently and worked at the disappointing rate of only about one acre per working day. The small tracks which had been fitted in place of the original wheels caused deep ruts in the ground which filled with water, made subsequent cultivation difficult and caused unevenness in the next crop.

The cutting and tying mechanism of this binder was driven from the tractor power-take-off and it performed quite satisfactorily even when the machine was nearly bogged. However, subsequent disposal of bound sheaves was difficult: if the crop was cut when dead ripe, shattering losses during reaping and stook building were excessive; if on the other hand the crop was cut earlier, the green straw heated in the stook and became progressively less stiff with each enforced re-stooking. Alternate wetting and drying by rain and sun caused considerable sun-cracking of the grain, while capping the stooks merely encouraged them to heat.

This binder was also tested in Province Wellesley in the 1949-50 season but it became bogged so frequently that the trials were abandoned after only a few hours of work. It was then concluded that the use of a reaper-binder in Malaya "is limited to conditions which are rarely encountered and can never be counted upon" (13).

Trials with a Prototype Header Unit.

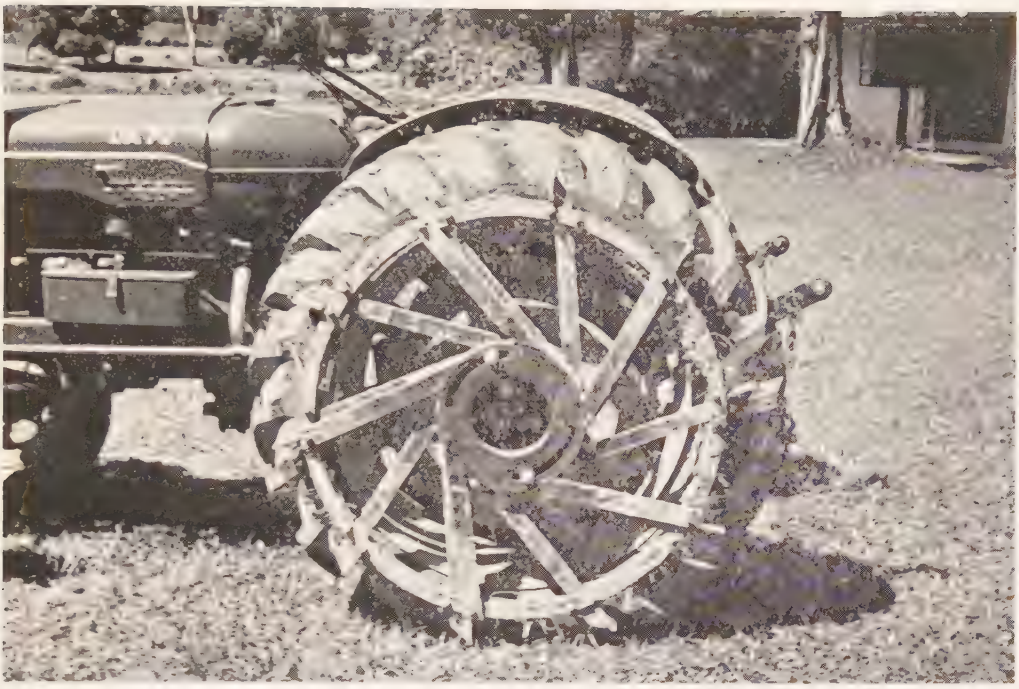
As a sequel to experiments with conventional cutter-bars a prototype header unit was developed in Kelantan in 1949, and trials on dry padi which were conducted in early 1950 have already been described in some detail (9). In general this unit performed well in spite of the normal mechanical troubles associated with all prototypes. It was very light and manoeuvrable; it could be used wherever a tractor could go and it could deal successfully with quite small plots. Carrying away the heads, which were threshed for convenience some 300 yards away, presented no great problem.

It was intended to follow up this promising lead by developing an improved unit with an elevator to carry the heads into a light-weight tank; however, staff shortages and inadequate and overstrained workshop facilities made this impossible. A pea-windrower made in the United Kingdom is now on the market and it is thought that this implement can be modified into a padi-header without any great difficulty. Since the manufacturers, although interested, proved unwilling to undertake conversion, a standard machine has now been ordered for modification in Malaya.

Combine Harvester Tests.

A McCormick Deering No. 52-R five-ft. combine harvester was imported from America in 1948 and, after some modification, was tested on bog soils at Chenderong Balai in 1948 (1) and again in the following season (2). It was then tested in the 1949-51 seasons and in the 1950 off-season in Province Wellesley, where it performed reasonably well in

PLATE I



Darvill Wheel Strakes fitted to a Fordson Major tractor.

PLATE II

Bombardier Half-Tracks fitted to a Ferguson TE-A tractor.

PLATE III

Ferguson TE-A Tractor, fitted with Bombardier Half-Tracks, ploughing under difficult conditions.

PLATE IV

The Tullos Thresher under test, Malacca, 1952.

small scale tests (13). However, in spite of modifications designed to reduce the bearing pressure, the limiting factor has usually been lack of floatation. Even in Province Wellesley the combine tracks sank so deep into the mud that the underside of the chassis scraped along the ground, thus increasing draught.

The actual threshing mechanism gave a fair grain sample after some adjustment but it was rare to obtain padi of comparable quality to that threshed in a stationary machine. It is possible that the rasp-bar type of cylinder and concave is less suited to threshing padi than the peg-drum of other machines.

This combine-harvester has since been tested in two seasons for the harvesting of dry padi in Kelantan and its performance has been considered satisfactory for those somewhat restricted conditions. However, for wet padi it is considered that on normal smallholdings a much smaller implement is required and it has already been noted that a mounted header is likely to prove suitable. Where a large-scale farm is laid out specifically for mechanised padi cultivation it is thought that the type of self-propelled combine-harvester which has given good results elsewhere in South-East Asia would be a more suitable machine than this trailed harvester. Funds for the purchase of such a machine were requested in July, 1951, with a view to trial during the following harvest but they were not made available. An order has now been placed and it is hoped that one will be tested during the 1953-54 harvest.

Simple Threshing Drum Tests

A simple, power-driven threshing drum, consisting of a 15-inch diameter drum, to the periphery of which were welded loops of steel wire, was made in Kelantan in 1949 (7). The drum was driven by a belt from a Farmall "A" tractor and was wide enough to allow two men to stand side by side and to hold sheaves against the revolving drum. Only padi cut with a sickle could be threshed as the straw had to be fairly long so as to afford a good hand grip.

Provided that the drum speed was adjusted to suit the work undertaken the samples of grain were comparable with those obtained from grain threshed in a tub by hand. Since no separate sieving devices were fitted, winnowing in the conventional manner was necessary. The performance of this simple thresher is summarized in Table IV.

Table IV.

Method of Threshing.	Output per Man-Hour in Lbs. of Padi.		
	Maximum.	Minimum.	Average.
By hand in tub	74.7	25.8	47.2
By power driven drum	64.0	25.8	45.6

It will be noted that no increase in output was obtained by the use of the drum but it was reported that the physical effort of beating the padi against the ladder in the tub was eliminated and that threshing was much less laborious. Similar threshing drums driven by foot treadle and of Japanese manufacture are now available for sale in this country at a very competitive price. Tests are in progress at several centres but verbal reports indicate that prolonged operation is more exhausting than hand threshing by an expert using a tub.

The chief disadvantage of this type of thresher is that it cannot handle the jumbled mass of heads on short lengths of straw which will require threshing in quantity if a suitable header is ever developed.

Tullos Thresher Trials.

The possibility that the absence of a suitable portable thresher might form a serious hindrance in mechanical harvesting made it necessary to embark on more extensive threshing trials and the necessary financial provision was requested in July, 1951. These funds were not made available, therefore the trials, although not completely abandoned, were re-cast on much more moderate lines and a cheap, Tullos hand threshing machine was imported in early 1952.

This Tullos thresher, which has not previously been described in this Journal, is a very small, simple machine designed especially for smallholders' use. It is made in two units which can be transported individually and is mounted on skids. The frame is fabricated from mild steel angles to which are attached sheet metal panels. The drum consists of a narrow cylinder, 24 ins. in diameter and 12 ins. wide, fabricated from mild steel and carrying four sets of cast steel, peg-type beaters. An adjustable feed plate, with pegs on its inner face, is mounted close to the drum. The lower half of the drum is surrounded by a perforated cast iron plate through which the grain passes and final separation is carried out by a pair of shakers which are removable. The drum may be driven by hand through a flywheel giving an 8.5 : 1 speed increase or by means of a 1 to 1½ h.p. engine. For experimental purposes the hand-driven version was chosen since it was felt that the lower cost and simpler maintenance would make it a more attractive proposition to smallholders. The weight of the Tullos in this form is 493½ lbs.

A test was carried out in 1952 at Pulau Gadong, Malacca. These trials were exceptionally well conducted and the greatest care was devoted to the organization of cutting, carrying and threshing. After a trial it was found that a team comprising six women for reaping, two men or women for carrying and five men for threshing was capable of harvesting an acre per day, but three of the threshers did not have to work a full day and could spend the first hour or two of the morning on other jobs.

Three different varieties were threshed simultaneously by hand and by the Tullos thresher. Considerable variations in time were noted but in all cases the Tullos was more rapid than normal hand threshing with a tub, and the separation of grain from ears was more complete,

especially when the straw was damp. The samples of grain obtained from the Tullos were comparable with, or slightly better than, those obtained by hand.

The work involved in driving the drum by hand was extremely arduous, especially where the straw was slightly damp or where a stiff-strawed variety such as Serendah Kuning was being threshed. The machine was demonstrated to padi cultivators and, while they admitted that the machine was efficient, they were most unfavourably impressed by the amount of work involved in turning the handle. The labour requirements for threshing by hand and by the Tullos thresher are set out in Table V.

It will be seen that the use of this thresher has reduced both the labour requirement and also the cost of threshing.

Subsequently an engine was mounted on this thresher in time for the 1952-53 harvest but early trials have been disappointing owing to drive difficulties which have not yet been solved. However, during a short test in Kedah, threshing ability was found to be good and it was considered suitable for padi field use in view of its compactness and light weight, as it was found to be practicable to transport it from field to field on a standard buffalo sledge or *anur*. Minor modifications are now being executed.

Robinsons Midget Thresher Trials.

Six of these small threshers were imported from Australia in 1946 for use with different crops. They are miniature, complete threshers with 26-inch wide peg drums and normal separating, sieving and winnowing mechanism. The main frame work is of angle-iron mounted on four small, steel wheels and the panels are of thin, sheet metal. All drives, except that to the fan, are by chains running on cast iron sprocket wheels and shafts run in oil-lubricated plummer blocks.

These Midget threshers have been used on a number of occasions but the most informative trial was carried out in Krian, Perak, in 1951. The machine in use had previously been completely overhauled but not modified in any way.

Data obtained from this trial are summarized in Table VI.

The grain sample from the Krian trial was satisfactory and it will be noted that mechanical threshing was appreciably cheaper than hand threshing. However, considerable mechanical trouble was experienced. The chains stretched very quickly and tended to jump their sprockets, and bearings became overheated unless very frequently lubricated. Operation was extremely noisy and some concern was felt regarding the danger from exposed chain drives. Cleaning out the thresher before changing to a new variety proved very difficult indeed.

In 1952, the best of these Midget threshers was rebuilt and fitted with vee-belt drives throughout and a mounted, 10 h.p. petrol engine. It was subsequently re-tested in Krian during the 1951-52 harvest but did not prove successful as the extra weight of the engine made it unmanage-

Table V.
Reaping and Threshing Trials, Malacca, 1952.
Average of Three Varieties.

	Hand Reaping and Hand Threshing.	Hand Reaping and Tullos Thresher
Labour required per acre:		
Reaping	52 Woman hours	48 Woman hours
Carrying	(Carried out by threshers)	13 Woman hours
Threshing	37.5 Man hours	14 Man hours
Total	89.5 Woman/Man hours	75 Woman/Man hours
Cost per acre:		
Labour *	$25.70	$17.86
Fuel	—	—
Depreciation	—	$ 0.20
Maintenance and Supervision	—	Negligible
Total	$25.70	$18.06

* Labour charges are based on the following rates: Labour (Male) — $2.60 per 8 hour day.
Labour (Female) — $2.08 per 8 hour day.

Table VI.

Reaping and Threshing Trials, Krian and Province Wellesley, 1951.

	Hand Reaping and Hand Threshing.	Hand Reaping and Mechanical Threshing.	Combine Harvester.
Site and Yield per acre.	Krian—1,790 lbs.	Krian—1,790 lbs.	Bukit Merah—1,778 lbs.
Labour required per acre:			
Reaping	320 Woman hours	320 Woman hours	2.8 Driver hours
Threshing	120 Man hours	3 Driver hours	5.6 Man hours
Winnowing	38 Man hours	15 Man hours	—
Total	478 Woman/Man hours	338 Woman/Man hours	8.4 Man hours
Cost per acre:			
Labour *	$116.24	$78.58	$ 3.79
Fuel	—	6.04	4.87
Depreciation	—	2.28	8.28
Maintenance and Supervision	—	5.00	15.00
Total	$116.24	$91.90	$31.94

* Labour charges are based on the following rates: Tractor Driver — $5.16 per 6½ hour day.
Labourers (Male) — $2.24 per 8 hour day.
Labourers (Female) — $1.80 per 8 hour day.

able on narrow bunds, while the high cost of carrying the padi to the nearest metalled road more than offset the saving in threshing costs which had been noted in the previous season.

Turner Economy Thresher Trials.

This modern thresher, which was imported from America in 1952 by the State Agricultural Officer, Selangor, has not previously been described in this Journal. It is a small, complete unit which is said to have been developed in co-operation with State Agricultural Experiment Stations and Extension Services of the Tennessee Valley Authority especially for use by small farmers. It is said to be capable of threshing all types of food grains and a capacity of 30 bushels (240 gantangs) of padi per hour is claimed.

For padi threshing the Turner is fitted with a peg-drum 28 ins. wide and 19 ins. in diameter. The particular model imported is belt-driven from a tractor pulley but provision is made for mounting a 6.8 h.p. air-cooled engine on the thresher chassis. After passing through the drum the grain is separated from the straw in a long, oscillating straw walker and then passes downwards through a set of three sieves to the grain delivery spout at the bottom of the machine. While it is passing through these sieves the grain is subjected to a blast of air which winnows away the chaff, dust and empty ears.

The drum shaft and all other fast moving parts run in roller bearings in dust-proof housings and grease lubrication points are provided for all bearings. The oscillation of the separators and grain shoe is controlled by a drive from a very large, eccentric bearing and there are only two vee-belt drives, one to the fan, the other to the eccentric.

The main framework of the thresher is made from channel and angle irons covered with galvanized sheets, but the chassis and drawbar are of wood. The model imported was fitted with two 6.00 x 16 pneumatic tyres on wheels with roller bearings which can withstand high road speeds. The wheel track of the standard machine is 68 ins. and, in working trim, the thresher is 12 ft. long and weighs 1,600 lbs.

Before the Economy Thresher could be used in the Tanjong Karang area, for which it was specifically intended, the wheel track had to be reduced to 48 ins. so that the machine could be towed over narrow bunds and bridges. Another modification necessary was the fitting of two extendable side arms which were clamped to the chassis behind the axle. To these arms were fitted screw jacks which could be lowered for operation and which kept the machine fairly steady and facilitated setting up on rough ground.

Preliminary trials with padi heads showed that the ratio between drum and shaker speeds was critical, but only one set of pulleys was available which gave a ratio of 5 : 1. With the drum running at 1,200 r.p.m. and the shaker at 240 r.p.m. the latter mechanism worked satisfactorily, but 35 per cent. of the grain was damaged and 10 per cent. broken. When the drum speed was reduced to 900 r.p.m. giving a shaker

PLATE V

The Turner Economy Thresher under test at Teluk Chengai, Kedah, January, 1953. The temporary double-strand fence in the foreground is a safety measure.

PLATE VI

The Turner Economy Economy Thresher under test. Note the screw-jack fitted beyond the wheel to give steadiness in operation.

speed of 180 r.p.m., broken grains were eliminated and only some eight per cent. was damaged, but severe blockages occurred on the shakers and sieves.

New pulleys for this machine were ordered in time for the 1952-53 season and trials are progressing. The first trial, in north Kedah, was carried out very thoroughly and the thresher performed efficiently with a drum speed of 700 to 820 r.p.m., a fan speed of 500 to 600 r.p.m. and a shaker speed of 240 to 252 r.p.m. Great care was necessary in setting up the thresher and aligning the tractor belt pulley. Operation was simple in dry weather but, after a heavy shower of rain, it was found impossible to follow the crop, therefore a central point threshing system had to be adopted with consequent increase in cost of carrying the padi.

The performance of the Turner Thresher in Kedah is summarized in Table VII and it will be seen that it took just over three hours to thresh 441 gantangs of padi (55 bushels).

Table VII.

Turner Economy Thresher Performance in Kedah Trials.

Trial No.	1	2	3
Variety	Radin Ebos	Reyong 20	Subang Intan
Test acreage	0.1	0.2	0.4
Yield in gantangs	91	118	232
Threshing time, minutes	50	60	80
Fuel consumption, gallons	0.875	1.05	1.40
Fuel consumption, gallons per hour	1.05	1.05	1.05
Out-turn per hour, gantangs	110.25	118.68	130.31
Yield per acre, gantangs	910	590	580
Yield per acre, bushels	113.75	73.75	72.50

In these trials labour costs increased rapidly with carting distance. Thus in the second trial the total labour required for carting the crop of Reyong 20 a distance of 10 chains to the thresher amounted to 37½ man-hours and 15 buffalo-hours. It is clear, therefore, that this machine, although efficient, is unsuitable for threshing padi cut by sickle or reaper-binder since it is not sufficiently mobile in Malayan padi fields. Nevertheless it is the most efficient thresher so far tested and it should be suitable for threshing a crop reaped by header.

Discussion.

Considerable progress has been made during the last two years in improving the technique of mechanical cultivation of wet padi land. With repeated improvements in detail it is now possible to tackle such work under more difficult conditions than was once thought possible. Further-

more, the more thorough the cultivation, the less difficult will be the problem of weeding the growing crop.

No progress has been made with mechanical transplanting but this need not limit development since the technique of broadcasting by fiddle has been fully proven in several trials.

Mechanical harvesting remains the major bottleneck but the problem is now clear: a light, mobile, tractor-mounted header is required for existing areas while, for special padi farms, a self-propelled combine-harvester on tracks has been considered worth a trial for the last two years. Certainly this type of machine is said to have performed well in other Asian countries, but conditions in Malaya are probably less favourable.

If a header is used, an efficient thresher must also be available. One such has been tested but it is not also suitable for smallholders' use in existing areas as it is not sufficiently mobile to follow the crop from field to field. It has been suggested that, if hand threshing in the field is to be replaced, some sort of tractor-mounted threshing drum must be developed *. This problem is relatively simple since no separating or winnowing mechanism need be incorporated as winnowing can be carried out at the smallholder's leisure.

The possibility of mounting a power-driven thresher on a Kedah type of buffalo-sledge has not been overlooked, as such a transport method is eminently suited to Malaya's difficult conditions.

Summary.

1. The case for the complete or partial mechanisation of wet padi cultivation is assessed in the light of ecological considerations.

2. Improvements in detail in the mechanical cultivation of wet padi land are recorded.

3. It is noted that no efficient padi transplanter is available anywhere in the world but that a promising prototype is under development in Italy. Drilling wet padi has shown little promise but a technique for broadcasting germinated seed has been evolved.

4. Methods of weeding and manuring the growing crop are considered. The use of aircraft can only be justified for very large areas.

5. The importance of good irrigation and drainage is stressed and it is noted that soil and climatic conditions in Malaya make the mechanisation of wet padi cultivation peculiarly difficult.

6. The all-important problems of harvesting are considered without complacency: reaping the crop is the chief hindrance to full mechanisation. Future progress still depends on the importation or development of new types of machines.

7. Recent threshing trials are described and discussed critically.

* Such a mounted thresher has recently been developed in Province Wellesley, and a short description is given elsewhere in this Journal (page 126).

Acknowledgements.

We are indebted to Mr. A. L. Barcroft, Agricultural Officer, for the information on the 1952 Tullos Thresher trials, and to Mr. P. G. Coleman, Agricultural Officer, Kedah, and Mr. J. A. Cox, Agricultural Development Officer, for notes on the Turner Economy Thresher. Trials with the latter machine would not have been possible but for the generosity of the Selangor Government in making available a State-owned thresher for Federal tests.

We owe much to discussions with Mr. E. W. Bewlay, Agricultural Development Officer, and to the able manner in which he has carried out many mechanical modifications.

Thanks are due to Mr. J. E. Mayne, Secretary of the Colonial Office Machinery Advisory Committee, for making available a copy of the translation of Angelo Alpe's paper on Italian transplanting machines.

The map of existing and potential padi areas has been specially prepared by the Drainage and Irrigation Department and grateful acknowledgement is made.

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BLISTER BLIGHT OF TEA IN MALAYA

3. Results of Further Spraying Experiments

BY

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Acting Senior Plant Pathologist.

Introduction.

An account of two experiments on the control by spraying of blister blight (*Exobasidium vexans*) of tea has already been published (1). The first of these experiments showed that good control could be obtained with several copper sprays, while the second, which compared the efficiency of different concentrations and volumes of Perenox, indicated that 10 to 20 gallons of 0.25 per cent. Perenox was a suitable dosage.

The experiments described below were carried out to confirm the results of these experiments and to obtain information on some additional points. Aspects of the subject investigated were:

(i) The efficiency of six copper fungicides,
(ii) The efficiency of four organic fungicides,
(iii) The effect of adding stickers or spreaders to copper fungicides,
(iv) The possibility of increasing the interval between sprayings, and
(v) The effect of reducing the concentration of fungicide.

The work was carried out at the Federal Experiment Station, Tanah Rata, Cameron Highlands, between May, 1951, and March, 1952. In all the experiments pruned bushes were used, the protection of bushes recovering from pruning being the most important aspect of blister blight control.

Methods.

Except where otherwise stated, the technique used was the same as that employed previously (1, p.161), the plots consisting of five pruned bushes surrounded by unpruned, guard bushes. Spraying was begun two to three weeks after pruning and continued until just before tipping, when blister blight infection was recorded. This was done by counting the leaf blisters on a random sample of 10 shoots from each bush.

In comparing the results of the experiments it is useful to have some standard by which to judge whether control has been adequate or not. For the present it has been decided to accept counts of less than 0.5 blisters per leaf as indicating satisfactory control.

Comparison of Copper Fungicides.

In the previous experiment, Perenox, Koneprox, Bordeaux mixture, Shell Copper Fungicide and Blitox all gave equally good control. In the

experiment described below these fungicides, with the exception of Bordeaux mixture, were again compared, together with Coppesan[1] (copper oxychloride) and SV Presovay[2] (copper naphthenate). Bordeaux mixture was omitted because although it gives good control the comparative difficulty of preparing it makes it less suitable for large scale use. SV Presovay was used at a strength of 1.57 per cent. as an emulsion in water, 0.1 per cent. Lissapol being added as an emulsifier. The other fungicides were suspended in water in the normal way at a strength of 0.25 per cent. The copper concentration was in all cases 0.125 per cent.

Bushes were sprayed at weekly intervals at a rate equivalent to 15 gallons per acre. Unsprayed plots were not incorporated but it was observed that blister blight attack on unsprayed bushes in the vicinity was heavy during the experiment. Treatment means, expressed as the average number of blisters per leaf, are shown in Table I.

Table I.

Test of Six Copper Fungicides.

Fungicide.	Treatment Mean. (blisters per leaf).	Total Stem Infections. (50 shoots).
Perenox	0.112	0
Coppesan	0.149	0
Koneprox	0.206	0
Shell Copper Fungicide	0.219	0
Blitox	0.256	1
SV Presovay	0.664	32

* S.E. = 0.132. † M.S.D. = 0.272. Layout: x 6 randomised block.

Perenox, Coppesan, Koneprox, Shell Copper Fungicide and Blitox gave equally good control but SV Presovay gave significantly poorer results. The control achieved with all fungicides except SV Presovay was satisfactory, the average number of blisters present being less than one on five leaves, while stem infections were almost completely suppressed.

Comparison of Organic Fungicides.

The following four fungicides, not based on copper, were available for trial—TMTD[3], Fylomac 90[3], EF5379[4] and EF5400[4]. Extensive trials

1. Boots Pure Drug Co. (Far East), Ltd. 2. Standard-Vacuum Oil Co.
3. Imperial Chemical Industries (Malaya) Limited.
4. Carbide and Carbon Chemicals Company.

* S.E. = Standard Error of the Difference between Treatment Means.
† M.S.D. = Minimum Significant Difference between Treatment Means (5 per cent).

in Ceylon (2) have indicated that such materials are unlikely to compare favourably with copper fungicides, but to discover whether there was any likelihood of their being effective under Malayan conditions an unreplicated experiment was carried out. One plot of 18 bushes was sprayed with each fungicide; in addition one plot sprayed with Perenox and one unsprayed plot were included for comparison. The plots were sprayed at weekly intervals at a rate of 15 gallons per acre.

Results are shown in Table II, figures being obtained from 10 bushes in every plot.

Table II.

Test of Four Organic Fungicides.

Treatment.		No. of Blisters per Leaf.	Total Stem Infections. (100 shoots).
Fylomac 90	0.25 per cent.	0.059	5
Perenox	0.25 „ „	0.117	0
TMTD	2.0 „ „	0.459	0
EF5400	0.2 „ „	0.885	51
EF5379	0.2 „ „	1.008	59
Not sprayed		1.079	72

Fylomac 90 (which is not recommended by the manufacturers as a foliage fungicide) caused very severe retardation of bud-break and growth; it is therefore not suitable for use against blister blight at the concentration tested. TMTD gave results almost as good as Perenox but the application rate was high (3 lbs. TMTD per acre as compared with 6 ozs. of Perenox). EF5400 and EF5379 did not give satisfactory control, infection of treated bushes being little less than that on unsprayed bushes. It thus appears that none of the organic fungicides tested is likely to be more suitable for use against blister blight than the copper fungicides now being used.

The Addition of Stickers and Spreaders to Copper Fungicides.

During heavy rain fungicides are liable to be washed off the leaf surface. By adding a sticker (a substance to increase adhesion) the efficiency of the fungicide can sometimes be increased. Another possible method of increasing efficiency is by the addition of a spreader or wetting agent which, by causing the spray droplets to spread over the leaf surface, increases the area of leaf over which the fungicide is potentially effective.

The effect of the use of such additives was tested in two experiments; in the first Perenox was used with Albolineum (a sticker and spreader) and Lissapol (a spreader), and in the second Shell White Oil (a sticker and spreader) and Teepol (a spreader) were used with Shell Copper Fungicide.

Perenox with Albolineum and Lissapol.

In this experiment Perenox was used at normal (0.25 per cent.) and half normal (0.125 per cent.) concentration, alone or with the addition of Albolineum (0.5 per cent.) or Lissapol (0.05 per cent.). Spraying was done at weekly intervals using 15 gallons of spray per acre. Infection, assessed in the usual way, is shown in Table III.

Table III.
Test of Perenox with Albolineum or Lissapol.

Treatment.		Treatment Mean. (blisters per leaf).
Perenox. per cent.	Additive.	
0.25	Lissapol	0.020
0.25	Albolineum	0.029
0.125	Lissapol	0.047
0.25	—	0.049
0.125	Albolineum	0.081
0.125	—	0.173

S.E. = 0.049. M.S.D. = 0.100. Layout: x 6 randomised block.

All treatments gave adequate protection. The addition of Lissapol or Albolineum to 0.25 per cent. Perenox resulted in a reduction in the number of blisters per leaf, but the difference was not statistically significant. Perenox at 0.125 per cent. with Lissapol added gave better control than 0.125 per cent. Perenox alone and as good control as 0.25 per cent. Perenox alone. Bushes sprayed with 0.125 per cent. Perenox with Albolineum had fewer blisters per leaf than those sprayed with 0.125 per cent. Perenox alone, but this difference was not statistically significant at the 5 per cent. point. The difference was significant, however, at the 10 per cent. point.

Shell Copper Fungicide with Shell White Oil and Teepol.

One concentration of fungicide (0.125 per cent.) was used alone and with the addition of 1 per cent. White Oil or 0.1 per cent. Teepol. Spraying (at 15 gallons per acre) was carried out at weekly intervals. Treatment means are shown in Table IV.

Table IV.
Test of Shell Copper Fungicide with Shell White Oil or Teepol.

Additive.	Treatment Mean. (blisters per leaf)
Teepol	0.028
Shell White Oil	0.054
—	0.072

S.E. = 0.023. M.S.D. = 0.051. Layout: x 6 randomised block.

Infection in all treatments was very light. The addition of Shell White Oil or Teepol did not significantly improve control.

Both the above experiments were carried out at times when conditions for blister blight attack were only moderately favourable. Under such conditions Perenox and Shell Copper Fungicide both gave satisfactory results at half the normal concentration. It would therefore appear that this reduced strength could safely be used during all except the wettest periods of the year. With Perenox the addition of Lissapol would be advantageous.

Increasing the Interval between Spraying.

It has so far been recommended that spraying of tea recovering from pruning should be done at intervals of seven days. Increasing the interval would reduce spraying costs considerably, so two trials were laid down to discover whether adequate control could be achieved by spraying at longer intervals.

In both experiments Perenox (0.25 per cent.) was used at a rate of 15 gallons per acre. Spraying was done at intervals of seven, 10 * or 14 days.

The first experiment was a replicated trial using the usual plot size of five bushes. The infection recorded in the three treatments is summarised in Table V.

Table V.
First Test of Different Spraying Intervals.

Spraying Interval. (days)	Treatment Mean. (blisters per leaf)	Total Stem Infections. (50 shoots).
7	0.201	0
10	0.716	8
14	0.801	12

S.E. = 0.130. M.S.D. = 0.289. Layout: x 6 randomised block.

* Actual interval was 10 and 11 days alternately, i.e. spraying was done twice every three weeks.

Spraying at intervals of seven days gave better control than spraying at intervals of 10 or 14 days. At the longer intervals the required standard of control was not reached and stem infections were rather numerous.

To discover whether these results would apply to spraying on a larger scale the second experiment was carried out, using four plots (including an unsprayed plot) each of 1/20th of an acre.

By the end of the experiment it could be seen that the plot sprayed at intervals of seven days was only lightly infected. The plot sprayed at intervals of 10 days had rather more leaf blisters but stem infections were few and control appeared to be adequate. The plot sprayed at intervals of 14 days had considerably more leaf blisters and stem infections were also more numerous. These observations were confirmed by a count of leaf and stem infections on 10 bushes chosen at random from each plot, 10 shoots being examined from each bush. Results are given in Table VI.

Table VI.
Second Test of Different Spraying Intervals.

Spraying Interval. (days)	Mean No. of Blisters per Leaf.	Total Stem Infections. (100 shoots)
7	0.046	0
10	0.371	1
14	1.208	8
No spray	6.954	201

All sprayed bushes had considerably less infection than unsprayed plants but the control obtained by spraying at intervals of 14 days was not adequate.

It is recommended that spraying should be done at weekly intervals if complete control is required. Spraying at intervals of 10 days will also give fairly good control and, except perhaps in the wettest periods, is likely to be sufficient. Spraying at intervals of more than 10 days is not recommended.

Concentration of Fungicide.

From a previous experiment (1) it was concluded that adequate control could be obtained using Perenox at a rate of 10 to 20 gallons per acre, and that the the total amount of the fungicide applied per acre should be between 2 and 8 ozs. As a check on whether these amounts would give good control different combinations of volumes and concentrations were tested.

Two volumes, 10 gallons and 20 gallons per acre, were used and the spray was applied at normal (0.25 per cent.), twice normal (0.5 per

cent.), half normal (0.125 per cent.) and quarter normal (0.0625 per cent.) strengths. All combinations of these volumes and concentrations which resulted in an application of between 2 and 8 ozs. of Perenox per acre were used, as is shown in Table VII where treatment means are also given. Spraying was done at weekly intervals.

Table VII

Test of Different Volumes and Concentrations of Perenox.

Weight of Perenox per acre.	Volume per acre.	Concentration.	Treatment Mean. (blisters per leaf)	Total Stem Infections. (50 shoots)
ozs.	gals.	per cent.		
8	20	0.25	0.155	0
8	10	0.5	0.165	0
4	10	0.25	0.193	1
2	10	0.125	0.303	2
2	20	0.0625	0.352	1
4	20	0.125	0.425	4

S.E. = 0.107. M.S.D. = 0.221. Layout: x 6 randomised block.

The most interesting point arising from this experiment is that all treatments gave satisfactory control, whereas unsprayed bushes in the vicinity were heavily attacked. It would thus appear that half the normal strength of Perenox could be safely used and even quarter normal strength, applied at 20 gallons per acre, would suffice. The conclusion that half strength Perenox might be adequate in the less wet periods of the year was reached as a result of an experiment described above (p. 85); it appears from the present experiment that this lower concentration might also safely be applied even in wetter periods of the year, when attack is likely to be heavier. Use of the weakest mixture tested (0.0625 per cent.) is not at present recommended.

Conclusions and Summary.

The main purpose of these experiments has been to discover ways in which control of blister blight by spraying can be achieved as economically as possible. Results indicate that spraying costs can be reduced without adverse results on the control obtained either by increasing the interval between sprayings from 7 to 10 days or by reducing the strength of copper fungicide by half (from 0.25 to 0.125 per cent.), when the addition of a wetting agent might be advantageous. Whether both these measures could be combined has not yet been investigated. The previous

recommendation that the volume of spray applied should be between 10 and 20 gallons per acre has not been altered, all field observations having confirmed the suitability of such volumes.

Tests of different materials confirm the superiority of copper fungicides; all products tried which contained copper oxide or copper oxychloride having proved satisfactory.

Acknowledgement.

Thanks are due to Mr. N. Kanagaratnam, Agricultural Development Officer-in-charge, Cameron Highlands, for help in the field organisation of these experiments.

References.

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2. PFAELTZER, J. W. (1951): "Studies in Blister Blight Control. IV. An Evaluation of Some Commercially Available Fungicides for the Control of Blister Blight."—*Tea Quarterly* **22**, 52.

COCKCHAFER PESTS OF CACAO AND OTHER CROPS

BY

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Introduction.

The subjects of this paper are certain cockchafers, mainly various species of the metallic black *Apogonia*, the leathery, brown *Chaetadoretus* and *Lepadoretus*, which cause severe damage to cacao leaves. All of these beetles are entirely nocturnal feeders and shelter by day to a depth of about two inches in the soil from which they emerge to feed just after sunset.

The young stages or "white grubs" develop entirely in the soil and are generally to be found in soil under grass growing between the cacao; attacks by these cockchafers are less in jungle plantings where the grubs are much scarcer in the soil. They are found further from the trees than adults and, in grassy areas, the grass is preferred to the cacao roots; the main food of all "white grubs" is vegetable detritus in the soil and roots.

The status of *Apogonia* has been recognised for many years in Malaya as a pest on such ornamentals as canna, but in 1938 *Apogonia cribricollis* Burm. was described as a serious pest of cacao (6) and two years later was said to be "by far the most important pest of the leaves of cacao" (13).

At that time, the area under cacao in Malaya was so small as not even to appear in the annual returns as serious expansion started only in 1948; the 1952 figures show there are 295 acres under the crop. The damage to the leaves by chafers is familiar to most readers and comprises irregular cuts or holes which may be severe enough to reduce the leaves to a network. Further details will be given later when describing leaf injury to cacao by the various insects concerned.

In 1950 Berwick, in an article (2), stated that severe damage by *Apogonia* and other species of flying cockchafers often prevents the establishment of cacao in the field. It is not necessary, therefore, to stress the economic importance of these beetles, even so far as cacao alone is concerned. It is interesting to note that one paper on cacao insects (13) mentioned only *Apogonia* among the chafers, and although minor leaf beetle pests were included, no mention was made of *Chaetadoretus* spp., though the type of its leaf injury is different.

Identification of *Apogonia* spp.

For over forty years it had been accepted locally that the only destructive species of *Apogonia* was *A. cribricollis* Burm., and a series sent to London in 1924 had been so identified through the Commonwealth

(then Imperial) Institute of Entomology. However, when it was noticed that this species had originally been described from Tongking (Indo-China) and Hong Kong in 1855, there was an element of doubt in the validity of the identification. A series was therefore sent to the Commonwealth Institute of Entomology in 1951 and examined by an expert there who found that a second species, *A.expeditionis* Rits., had all along been confused with *cribricollis*. Further collecting on cacao showed that both species occur, the latter being commoner. In addition there is another, smaller species, *A.laevicollis* Lansbr., which although also found on cacao is much commoner on *menarong* (*Trema orientalis*). In Kalshoven's new text book (11) (not yet translated from the Dutch), it is stated that the Indonesian *A.destructor* Bos. may be identical with *A.cribricollis*.

No attempt has been made in this paper to treat the two larger species separately as their habits and biology are very similar. In fact, so far as the adults of these species are concerned separation in the case of the males entails dissection of the genitalia, while females can be distinguished only by the capture of paired couples, and the subsequent dissection of the associated male concerned.

The copulatory organ (aedeagus) in *A.cribricollis* tapers towards the tip and is somewhat delicately built while in *A.expeditionis* it is of almost uniform width with a down curving tip, is stouter and more heavily chitinised. The male genitalia are figured in Plate II, Figs. g, h and i.

Many of the series of pinned specimens of *Apogonia* in the Departmental collection, taken from a very wide range of food plants, are now from 25 to 30 years old and some are represented by only two or three examples. Measurement of the ratio of certain portions of the body was suggested to the writer by the Senior Entomologist in an effort to separate the two species. The data recorded were length to width of thorax (pronotum) and wing cases with the distribution and intervals between the punctures. No interspecific differences were found which could be used to separate these two very similar species neither did they show any differences under the ultraviolet lamp, which sometimes reveals a variation in the amount of glowing between different species.

At least six other species of *Apogonia* are known to occur in Malaya: viz., *A.gigantea* Nonfr., the largest, is 13 mm. long while *A.pallescens* Westw., the smallest, is only 5 mm.: the remaining four, *A.aeneocuprea* Msr., *A.vicina* Burm., *A.orbitalis* Rits. and *A.punctata* Rits., are all between 8 and 11 mm. in length. As none of these six beetles has so far been recorded as an actual cacao pest they are not referred to again; they can, however, all be considered as liable to attack this crop. The presence of *A.vicina* Burm. was unexpected as it was originally described from Pondicherry, India, in 1855 and was not recorded in Malaya until 1952. One specimen has been taken feeding on a cacao tree at Serdang since the key, which follows, was compiled.

Key for Identification of Chafers.

The following key should aid in the identification of all the chafers

which regularly attack cacao. Chafers have fan-like tips to the antennae, which are short and concealed under the head. Lengths are given in millimetres. (For conversion, 25 mm. equal 1 in. approx.) Figures will be found in Plate II, Figs. a to f.

A. Beetles without White Pubescence or Prominent Ridges on Wing-cases.

1.	Black, glossy, 7-10 mm.	2
	Not such beetles	3
2.	Thorax densely punctate, 8-10 mm.	*A.cribricollis* Burm. and *A.expeditionis* Rits.
	Thorax sparsely punctate, 7-8 mm.	*A.laevicollis* Lansbr.
3.	Orange-brown, coarsely grooved wing-cases, shiny	4
	Blackish-brown, finely grooved wing-cases, dull matt	5
4.	Head darker than thorax, 12 mm.	*Anomala pallida* F.
	Head same colour as thorax, 7 mm.	*Neoserica apogonoides* Brske.
5.	Dull matt, bristles on margins of thorax and wing-cases, 8 mm.	*Autoserica* sp.

B. Beetles with White Pubescence and Prominent Ridges on Wing-cases.

i.	Pubescence of fine, white hairs and longer bristles	
	Front tibia with three, sharp, equidistant teeth	*Chaetadoretus cribratus* (White)
	Front tibia with blunter teeth, proximal being further from central tooth than is the outermost (distal)	*C.borneensis* Kraatz.
ii.	Denser pubescence of uniform, tapering white scales	*Lepadoretus compressus* Weber.

Not included in the above key is one species of chafer which is only rarely found on cacao and readily recognised by its size and colour alone. This is the large (25 mm.) chafer *Anomala cupripes* Hope, glossy green above and metallic purple below. It has only once been recorded as attacking the leaves of cacao but its grub causes minor injury to the roots.

Other Beetle Leaf Pests.

Besides the chafers already dealt with there are five other beetles which cause some damage to cacao leaves and are dealt with briefly. A key for identification is as follows:—

1.	Antennae longer than body		2
	Antennae shorter than body		3
2.	Black thorax, spots on wing-cases white, 12 mm.	*Glenea funerula* Thoms.	
	Blackish-brown, five white stripes on thorax, long marginal white stripe and small transverse bar on wing-case, 15 mm.	*Glenea extensa* Pasc.	
3.	Antennae thread-like, not elbowed, total length about 5 mm.		4
	Antennae clubbed & elbowed, total length 15 mm.		5
4.	Uniformly brownish-yellow, wing-cases grooved	*Phytorus dilatatus* Jacq.	
	Head and thorax brown, metallic green wing-cases, punctate	*Nodostoma aeneipenne* Baly	
5.	Pubescent, lemon-yellow wing-cases (black when abraded)	*Hypomeces squamosus* F.	

The damage caused by the longicorn *Glenea funerula* is unlike that of any other insect of cacao; it takes the form of narrow incisions along the lateral veins as if portions of these had been removed with fine scissors. This beetle has so far been taken on cacao only in Trengganu where it has apparently recently switched to this crop from the jungle tree *Baccaurea brevipes* Hook. which shows similar leaf damage. *G.extensa* is much scarcer and has also so far not been recorded except in Trengganu.

In the case of *Phytorus* and *Nodostoma*, it is the tender, apical leaves which are reduced to a fine network. These beetles often shelter by day in the curled-up leaves which may be killed by the injury.

The large weevil *Hypomeces* eats the edges of the leaf, removing large portions of the tissue. It is a common pest on rambutan, mango, coffee, citrus and ornamental hibiscus.

Distribution of *Apogonia* spp.

The world total comprises over 200 species of *Apogonia*, all being found in Asia and Africa. In Borneo, over 40 species have been recorded, but in Malaya only nine*. Throughout the vast area from India and Ceylon through Indo-China to Indonesia many important crops (citrus, teak, sugar cane, soya and coffee) besides cacao are prone to attack by various species of *Apogonia*.

The two economic species, *A.cribricollis* and *A.expeditionis*, have been taken in all States; however, in Trengganu, although recorded on cacao they appear not to reach pest proportions on this crop.

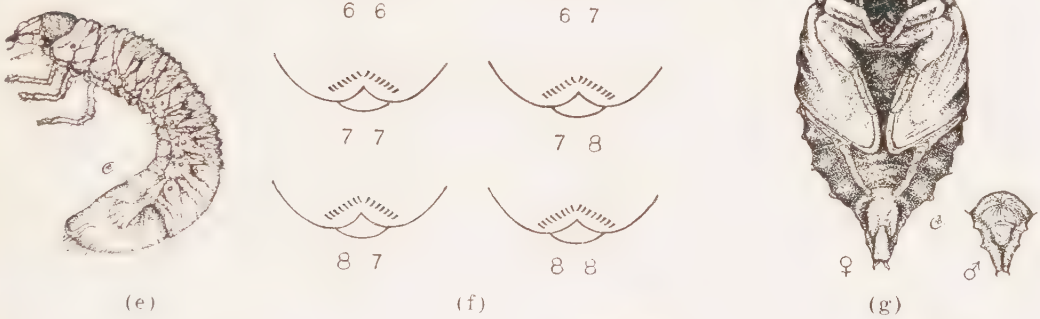
A.cribricollis has been recorded from Singapore, Pulau Tekong Besar and Labuan Island, British North Borneo (7), in addition to the Malayan peninsula. This genus was referred to as attacking coffee,

* A tenth species, unknown to the British Museum, has since been taken.

PLATE I

APOGONIA CRIBRICOLLIS BURM.

(a) (b) (c) (d)



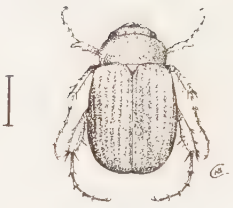
(e) (f) (g)

(h) (i) (j)

(k)

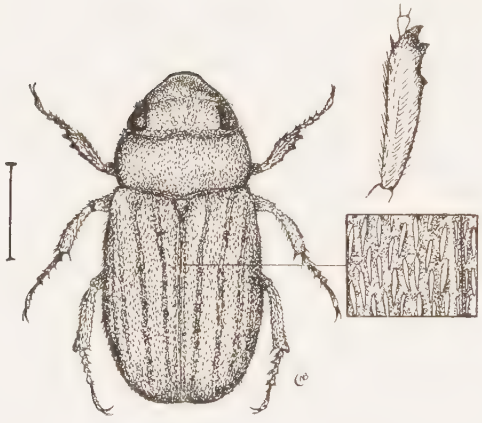
(a) newly laid egg x 12;
(b) egg due to hatch x 10;
(c) larva hatching from egg x 10;
(d) young larva x 22 showing mandible;
(e) larva x 3½;
(f) Variation in raster;
(g) female pupa with apex of male x 4:
(h) adult x 4; head and antenna of
(i) female and (j) male;
(k) *Apogonia laevicollis* Lansbr. x 3.

(a)

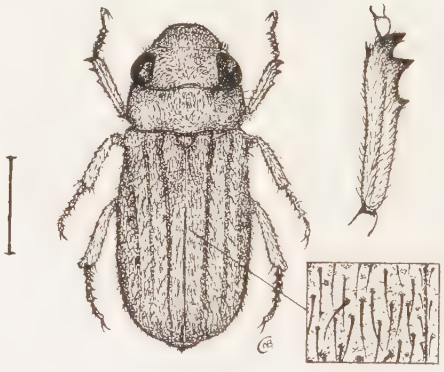


(b)

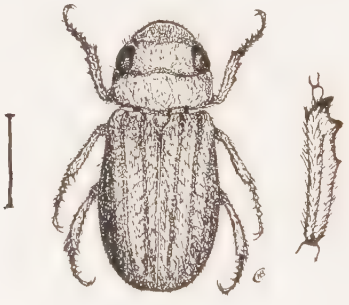
(c)



(d)

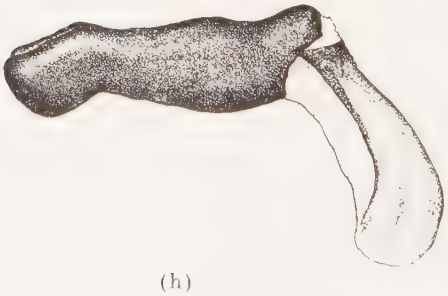


(e)



(f)

(g)



(h)

(i)

(a) *Anomala pallida* F.; (b) *Neoserica apogonoides* Brske.; (c) *Autoserica* sp.;
(d) *Lepadoretus compressus* Web.; (e) *Chaetadoretus cribratus* White; (f) *Chaetadoretus borneensis* Ktaa
Aedeagus of:
(g) *Apogonia cribricollis* Burm.; (h) *A. expeditionis* Rits; (i) *A. lacvicollis* Lansbr.

durian and roses on the Peninsula as long ago as 1908 (14), and the species concerned then was probably *cribricollis*.

Leaf Damage to Cacao.

Leaf damage by chafers was mentioned in the Introduction but is amplified here. It may be of one or two main types, either chewing irregular portions, mostly from the edge of the leaf (Plate III, Figs. a and c), which may be extensive enough to leave little more than the midrib and main veins, or a fine network results (Figs. b and d) due mainly to eating from the centre of the lower leaf surface often leaving the cross-veins. These two types are caused by *Apogonia* or by *Lepadoretus* and *Chaetadoretus* respectively but it happens that all may be found feeding on the same branch or occasionally even on the same leaf. Damage is most severe on trees grown in the open, becoming less as the density of the overhead cover is increased by the growth of certain leguminous covers, minimum injury being caused under the denser shade of jungle trees. On the other hand, damage by the large, yellow and green grasshopper *Valanga nigricornis* Burm. and the smaller, brown *Catantops humilis* Serv. is most severe to cacao grown under jungle conditions where chafer damage is often negligible. Feeding by grasshoppers causes larger and more irregular leaf injury than that caused by *Apogonia* and may take the form of oval or circular cuts in the centre of the leaf.

While attack by chafers occurs throughout the life of the tree, it is during its young stages that most damage is caused because there is then a relatively high loss of leaf-tissue compared with the total foliage available. These beetles feed between dusk and daybreak and then take cover in the soil, where they remain buried during the day, and are not seen unless dug up. The writer has on several occasions been asked to visit young cacao and other plantings which showed such intensive injury as to have reduced the leaves to a network. Previous to the writer's visits all searches had been confined to daylight hours when the beetles were a couple of inches underground and accordingly were never seen.

Other Host Plants.

Some early records of *Apogonia* are of interest; damage to coffee and durian trees in 1908, apparently the first local report of this genus, has already been mentioned; the beetles were said to have mined the underside of older leaves and young shoots of the coffee (14). In Singapore damage was reported to the wild poinsettia (*Warszewiczia coccinea*) on which *Apogonia* was said to have caused "continual trouble" in 1924 in the Botanic Gardens (3).

Besides cacao, the following plants have been recorded as damaged by *Apogonia cribricollis* (an asterisk denotes new records obtained between 1951 and 1953):—

Acalypha wilkesiana *
Achras sapota (sapodilla)
Lettsomia sp. *(convolvulus)
Melastoma malabathricum * (Straits rhododendron)

Bixa orellana (anatto)
Camellia sinensis (tea—lowland)
Canna indica & C.orientalis (flowers)
Coffea liberica & C.robusta
Dahlia spp.
Derris elliptica & D.malaccensis
Elaeis guineensis (oil palm)
Flacourtia inermis (rukam)
Glycine max (soya bean)
Grewia paniculata * (chenderai)
Hibiscus mutabilis * (rose of Sharon)
Hrose-sinensis (shoe flower)
Honckenya ficifolia *
Ixora spp.
Moringa oleifera (horse radish tree)
Muntingia calabura (West Indian cherry tree)
Musa textilis (Manila hemp)
Mussaenda erythrophylla *
Nephelium lappaceum (rambutan)
Palaquim gutta (gutta percha)
Rosa spp.
Sesbania grandiflora (turi) *
Trema orientalis (menarong) *
Vigna sinensis (dwarf cowpea)
Vitis vinifera (grape)
Warszewiczia coccinea (wild poinsettia)
Zinnia spp.

Doubtless a still larger number of trees and ornamentals remain to be recorded by intensive collecting at night.

Despite the wide variety of plants attacked, *Apogonia* is by no means omnivorous, thus young *Barringtonia racemosa* growing close to cacao and *Lagerstroemia flos-reginae* near cannas were quite free from *Apogonia* though both trees were very heavily attacked by *Chaetadoretus* and the nearby cacao and cannas had been damaged by *Apogonia*.

Life History and Description of Stages.

The newly laid egg (Plate I, Fig. a) is glossy white, elongate oval in shape and covered with a sticky secretion to which soil particles readily stick; at this stage it is easily ruptured by adhering, sharp sand-grains when manipulated for examination with a camel hair brush. Its breadth when laid varies from 0.9 mm. to 1.1 mm. and its length from 1.2 mm. to 1.4 mm.; during development of the embryo the egg changes from white to a cream colour and swells to measure 1.3 mm. in breadth by 1.6 mm. in length so as to be almost globular. A day or two prior to hatching, the mandibles of the developing larva are clearly visible as two brown, thorn-like bodies (Plate I, Fig. b), and the egg assumes a delicate pink colour. There is no hatching spine or egg-burster as occurs in some members of this family. Fig. c shows the egg shell partially investing the emerging larva.

Certain much larger spherical objects, 4 to 5 mm. in width and somewhat like small pearls, are found in the soil under cacao trees. These are the eggs of earthworms; their relatively large size, four or five times the width of *Apogonia* eggs, prevents any confusion in the field.

The eggs of *Apogonia* are laid singly, each within a pellet of slightly compacted earth at a depth of one or two inches in the soil. These individual pellets are enclosed within a larger friable crust so as to form a delicate but distinct mass containing the eggs. Under laboratory conditions the usual batch laid varies from 15 to 20 in number but may be as few as five to seven or as many as 35. Dissection of female beetles

PLATE III

Fig. a

Fig. b

Field damage to cacao by (a) *Apogonia* and (b) *Chaetadoretus*.

Fig. c

Fig. d

Detail of leaf injury by (c) *Apogonia* and (d) *Chaetadoretus*.

PLATE IV

(a) Collecting chafer larvae. Note knife where soil removed, steel frame and sledge hammer.

Lalang guard on supports around young cacao. Sungei Udang, Malacca.

showed up to 27 fully-formed eggs in the ovaries. In the laboratory on two occasions three batches, totalling 44, 46 and 46 eggs, have been laid by one female.

Out of 140 batches of fertile eggs, no less than 132 hatched in nine days, only six batches taking eight days and two taking 10 days so that the average period of incubation, under laboratory conditions, is nine days. If the soil is too dry the embryo fails to develop, and if it is too wet then mould grows on the eggs and they do not hatch.

The larva is a typical, curved "white grub" with a wrinkled skin covered sparsely with fine hairs (Plate I, Fig. e). In a paper (4) on the identification of grubs from rubber estates, *Apogonia cribricollis* was briefly mentioned as a minor root pest and was said to be a member of the family Rutelidae, which should have been the family Melolonthidae.

Separation of the various species of chafer depends on the degree of development and disposition of spines on the ventral surface of the last abdominal segment, which in life is flexed under the curved body. As shown in Plate I, Fig. f, these spines may occur in groups having 6 and 6, 6 and 7, 8 and 6, 7 and 7, 8 and 7 or 8 and 8 spines on each side giving respectively 12, 13, 14, 14, 15 or 16 spines in all. Larvae with the combination 6,6 and 7,7 emerged into *cribricollis* and 7,8 and 8,8 into *expeditionis*.

The larva on hatching is 3 mm. in length, white in colour, with the tips of the mandibles and other mouth-parts pale brown (Plate I, Fig. d). In the early stages the ratio of the head in proportion of the body is much larger than in the more mature larva. The legs are long, hairy and white and the ratio of their length relative to the body decreases during development; the head changes in colour from white to pale brown. After about eight weeks the larva has a length of 12 mm., and prior to pupation, 10 to 11 weeks after hatching, is 15 mm. long. The terminal portion is grey due to the contents of its hind gut consisting chiefly of ingested soil and fine roots.

Larvae have been reared into pupae in as short a time as 67 days and up to 77 days; the most usual period is about 72 days (see Table I).

The best medium for laboratory rearing was found to be seedlings of the spinach *Talinum triangulare* grown in fine soil in wooden boxes; the next was sieved compost and cow dung with fine roots of grass or sensitive plant.

Attacks by mites occasionally kill the grubs. In the field, the grubs are found in periods of dry weather at a depth of 4 to 5 ins. as against only 2 to 3 ins. in wetter months.

Prior to changing into a pupa, the larva forms a firm cell formed from earth cemented with a secretion. In this cavity it sheds its skin and rests in the non-feeding prepupal stage. Handling of any kind at this period invariably results in fatal injuries as the insects are then at a critical stage of their development. Laboratory records of this phase are therefore very meagre and it is not known exactly how long this

period lasts but it is believed to be about 2 to 3 days. Prepupae have not been taken uninjured in the field.

The pupa is ivory-coloured, darkening to a pale brown just before the change into the beetle. Its length is from 10 to 12 mm., this is greater than that of the adult as the posterior segments of the pupa are produced prior to their retraction as the final stage is assumed. The prepupal and pupal development together take 11 to 12 days. The different structure of the terminal abdominal segment can be seen in Plate I, Fig. g.

The above facts deal primarily with *Apogonia* but hold good generally for related genera.

The total life cycle will be seen to be about three months; all stages are set out in detail in the following table which for comparison includes three other cacao chafers. Figures in brackets denote the number of specimens of each stage dealt with, except that for the eggs which are batches.

Table I.
Development Stages of Chafers.
(Times in Days)

Beetle.	Egg Range.	Egg Average.	Larval Range.	Larval Average.	Prepupa & Pupa.	Average Total Cycle.
Apogonia cribricollis Burm. and *A.expeditionis* Rits.	8-10 (140)	9	67-77 (19)	72	11-12 (16)	93
Chaetadoretus cribratus (White)	11 (5)	11	88-90 (5)	89	10-12 (5)	111
Anomala pallida F.	10-12 (6)	10	92-107 (6)	99	12-13 (6)	125
Autoserica sp.	7 (8)	7	67-69 (5)	68	11 (5)	86

It is of interest to note that *Apogonia destructor* Bos. in Java is stated by Dammerman also to have a life cycle of about three months (5). This beetle attacks cacao as well as groundnuts and soya bean; its larvae feed on roots of sugar cane. As mentioned earlier, it has recently been suggested that this beetle may be identical with *A.cribricollis* (11).

For the first 12 to 16 days after emergence from the earthen cell *Apogonia* is chestnut-brown in colour, gradually darkening to black. Consequently one may find brown and black coloured individuals feeding on leaves or resting together in the soil.

Separation of the sexes without dissection requires careful examination with a good hand-lens. If the antenna, which lies in a depression close to the lower margin of the eyes, is exposed with a fine needle it will be seen that there is a marked difference in the relative length of the fan-like terminal portion and the six preceding bead-like segments. This sexual difference is more marked in the Rutelids (*Chaetadoretus*) than in the Melolonthids (*Apogonia*). In the male the fan is noticeably longer

than these six segments together while in the female it is shorter (Plate I, Figs. i and j). When viewed sideways it will be seen that the terminal abdominal segments of the male extend further beyond the wing tips than the female but this character is not pronounced enough to separate a series of both sexes.

Adults collected in the field have been kept alive in the laboratory up to four months, in one case for just under six months. In Table II these records have been grouped into convenient periods; beetles which died in under one month were ignored as they were regarded as being already old at the time of capture.

Table II.

Longevity of *Apogonia* Adults in the Laboratory.

Duration of Life.	No. of Individuals.
days	
30 — 60	23
61 — 90	26
91 — 120	16
121 — 150	4
151 — 177	1

Apogonia is able to go without food for a much longer period than can *Lepadoretus*, starvation tests showing the former to have a 50 per cent. mortality in eight days and 100 per cent. in 12 days whereas with *Lepadoretus* 50 and 100 per cent. mortality occurs in only three and five days respectively.

Notes on Habits.

Larva.

The larva on hatching ruptures the membranous "egg shell" irregularly (Plate I, Fig. c) and emerges as a delicate organism 3 mm. in length. Unlike some other members of the cockchafer family, the larva of *Apogonia* is able to walk on a perfectly smooth surface. When placed on the surface of soil it rapidly burrows out of sight.

The larvae will engage in extensive cannibalism or cause each other fatal injuries when confined too closely in containers. The normal food of larval chafers is roots and decaying vegetable matter in the soil but actual root damage to cacao by *Apogonia* has not been reported or seen. As mentioned earlier, this sometimes occurs with the large grub of *Anomala cupripes* Hope which appears to be of negligible importance as a pest on cacao leaves when adult.

Observations on the habits of strictly subterranean insects are not easily made but from field collections these grubs are usually found at a depth of from two to four inches. Their natural position is with the concave side uppermost, which results in the mouth-parts being towards the surface.

ADULTS.

As is well known, all cacao chafers are strictly nocturnal, emerging from the soil about dusk, feeding throughout the night and burying themselves at first light.

Observations made on a *menarong* tree (*Trema*) over several months showed that the brown chafer *Chaetadoretus cribratus* (White), also a cacao pest, usually arrived a few minutes earlier than *Apogonia* and was already feeding in the centre of the leaves when the first of the latter beetles began to settle on and eat from the edges. *Chaetadoretus* is more easily disturbed and feeds higher in the tree. *Apogonia* beetles were often observed resting or copulating on blades of grass before flying up into the leaves. Copulation is more usual, however, on the leaves and occurs soon after arrival there and usually between 7 and 8 p.m. local time, i.e. it is usually restricted to the first half hour after the nightly emergence, which is about 25 minutes after sunset. Feeding is less on very wet nights.

Apogonia beetles are attracted by artificial light, *Chaetadoretus* hardly at all. Flights of the former are said to occur in late September and October in the Kinta Valley, and in Selangor beetles are very abundant in the latter month and November. In East Java the flight is said to be November to January (11).

Soil Population Studies.

Estimating populations of soil insects is known to show great fluctuations and requires a very large number of samplings in order to give any reliable figure. However, it seemed worth while to make an attempt in order to calculate the approximate numbers of larval *Apogonia* to be found per acre. The area chosen was a former pasture in which cacao was planted out at 11 x 11 ft. (square), a total of 360 trees per acre. The soil was a brown sandy loam with 23 per cent. clay in the top six inches; the area was a gently sloping piece of land at the Federal Experiment Station, Serdang. It was noticed that larvae were usually more numerous in those spots which were more clayey.

Furrows of 175 yds. in length were ploughed in December, 1951, with a tractor-drawn mouldboard plough, set at 4½ and 6 ins. in depth. Fourteen samples, each of two square feet, of the shallow and seventeen of the deeper ploughings gave respectively 0.5 and 1 larva per sq. ft. A total of 189 larvae was thus recorded but only six beetles were found.

A check was later made by taking small blocks of soil and counting the larvae in each. The method employed involved using a square, iron frame with sides one foot long and of six inches depth with a cutting

edge: this frame was forged at the Workshop and Pool, Serdang. The types of auger used to make putting holes in golf greens or for taking regular soil samples for chemical analysis were too small for the purpose and the sample used was considered to be the smallest size likely to give reliable results.

This frame was driven into the ground with a sledge hammer, prised up and the resulting soil section, some 4 ins. deep, removed to a tarpaulin, broken up and the insects counted (Plate IV, Fig. a). Twenty soil samples were taken from each of three rows between the trees, each row being 150 yds. long.

The numbers of insects found in the total of sixty samples in three strips at four inches depth were as follows:—

Strip 1, 15 larvae or 0.75 insects per sq. ft. sample.
„ 2, 14 larvae and 3 adults (17) or 0.85 insects per sq. ft. sample.
„ 3, 39 larvae or 1.99 insects per sq. ft. sample.

This shows a large variation per strip in the number of insects present, but as a rough guide to the population one can take an average of one insect (all stages) per square foot throughout the arable area, which compares well with those obtained during ploughing. These counts were made in April and May, 1952, and may not hold good throughout the year and will also vary considerably with the type of soil, being less abundant in the drier or more sandy portions.

When counts were made by removing soil to a depth of three inches from under 25 cacao trees a total of five grubs and 32 beetles was taken, showing an average of one grub to every five trees (0.2 grubs per tree) and 1.2 adults per tree.

In order to get an accurate figure one would require a team of trained diggers as this type of work is quite unsuitable for casual labour. However, it seems justifiable to give the following approximate population per acre from one field for one particular time of the year:—

Table III.
Population of *Apogonia* from Soil Collections.
April and May, 1952.

	Nature of Site.	Area.	Insects per Sq. Ft.	Total Insects in Round Numbers.
		sq. ft.		
(i)	360 trees, 6 sq. ft.	2,160	1 (mostly beetles)	2,000
(ii)	Pasture between trees	41,400	1 (mostly grubs)	41,000 *
		43,560 (1 acre)		43,000

* Annual Report for 1949/51 of the Pathological Division of Rubber Research Institute of Malaya, March, 1953, p.43, gives 35,000 larvae per acre of another chafer under rubber in Kedah.

Figures published by the Department of Agriculture, Mauritius, (17) showed that larval sugar cane chafers (*Clemora smithi* Arr.) varied from 33,500 to 40,500 per acre in the Flacq area of Mauritius in 1935, though up to 145,000 grubs were reached in some places. The Malayan figure of 43,000 is therefore comparable with the figures quoted from Mauritius.

A recent paper by Salt (15) gives figures of several species of beetles from diverse sites in Tanganyika and so is not comparable with the above figures. This author mentions the scantiness of quantitative information on the insect fauna of tropical soils and stresses the need for great care in drawing conclusions from soil sampling. This agrees with another worker in East Africa (Le Pelley) who had previously shown (12) that it was impossible to obtain a satisfactory insecticidal control based on field sampling owing to the great variation in the numbers of grubs in different portions of any area selected.

However, the above figures, apparently the only quantitative ones published on Malayan soil insects, give some indication of the numbers that may be present under certain conditions.

That the nature of the medium in which shelter is taken has a profound effect on the numbers of insects present was noticed in one area of young cacao where a layer of sawdust had been used as a mulch. This material was found to be very attractive to *Apogonia*, no less than 55 beetles being found under one tree on one occasion which is greater than a batch of eleven beetles also taken on one occasion in a similar site in normal soil. Sawdust might be utilised in small nurseries as a means of trapping the beetles provided the area so covered is thoroughly raked over to collect the beetles. When banana leaves or cut stems are placed between rows of cacao it has been observed by the Senior Entomologist that large numbers of beetles were found sheltering beneath them.

An interesting field observation is that although *Chaetadoretus cribratus* (White) was, next to *Apogonia*, the most abundant beetle feeding on cacao leaves, yet only rarely were its grubs or adults found in the soil beneath the trees. The second most numerous insect taken in this site were the grubs and adults of *Anomala pallida* F. Relative counts of other chafers collected were not made, work being concentrated on *Apogonia*.

Biological Control.

Only one parasite has been reared from *Apogonia*, viz. an unidentified *Tiphia* wasp. The larva of this parasite feeds on the contents of its host to which it is attached externally on the dorsal surface of the last thoracic segment on which the egg was laid (Plate V, Fig. a). Only three larval specimens have so far been found and only one of these developed into an adult, a male. The *Tiphia* larva spins a fawn-coloured, silken cocoon inside the body of its host. The adult is a black wasp with brown antennae, tibiae and tarsi; it has a total length of just over 5 mm. These ecto-parasitic larvae were obtained at Serdang in April and May,

1952, during the population counts referred to above. A specialist on the genus *Tiphia*, Mr. C. Jacot-Guillarmod of Basutoland, is unable to place this *Tiphia* and states that it is a new parasite record for *Apogonia*.

On one occasion the empty puparium of a Tachinid fly was found within the body of a dead *Apogonia* beetle in the soil. Dammerman (5) has recorded a species of *Masicera*, and W. F. Jepson bred *Prosena siberita* F. from *A.destructor* Bos. in Java (10).

In the course of digging for larvae one often finds swarms of the small ant *Pheidole* sp. at a depth of several inches but no instances of their workers actually attacking the *Apogonia* grubs were ever seen. In one case a live and apparently healthy specimen of *Apogonia laevicollis* on a cacao tree was found being attacked by a cluster of keringga ants (*Oecophylla smaragdina* Feb.) but this is a rare occurrence as the beetles are nocturnal.

Hermaphroditism.

While making dissections of *Apogonia* late in May, 1952, four hermaphrodites (male and female organs present in one individual) were found, all beetles having been taken on a *menarong* tree in the writer's garden. Early in June, 1952, a fifth specimen was found but further collecting did not produce any more. The eggs found numbered 5, 6, 9 and 14, the remaining specimen having undifferentiated ovarioles. It was not possible to trace any connection between the testis and oviducts so as to see if it was functional hermaphroditism. These five hermaphrodites were found out of about 120 male beetles dissected but it must not be concluded that a ratio of 1 to 24 is the normal one as counts of males dissected before the first hermaphrodite was found were not kept. Plate V, Fig. b, shows one of these beetles.

Two of these individuals were sent to the Commonwealth Institute of Entomology whose Director commented that the discovery of hermaphroditism in the Melolonthidae was of exceptional interest, being quite unique and it had aroused much interest in London.

Pressure of normal duties has not allowed of the further dissection of these beetles which were used instead for insecticidal tests. Although this finding is very interesting it is of no economic value and so has not been pursued.

Non-Biological Control.

I. Prewar.

The earliest suggested method of control appears to date from 1909 when it was recommended (14) that the beetles should be collected by hand trowel at a depth of one to three inches from soil beneath coffee trees. This is sound enough for small areas though a light *changkol* would probably prove less tiring.

Cacao was not grown as a commercial crop in Malaya before World War II, but in 1938 two methods of controlling leaf injury by

Apogonia were published (6). These were spraying with lead arsenate at the rate of 1 oz. in 4 gallons of water (this was stated to fail in wet weather) or digging in 2 ozs. per tree of calcium cyanamide to stimulate growth and make the soil immune to beetle attack. Later (13) the concentration of arsenical was increased from the above rate of 12½ ozs. in 50 gallons (0.15 per cent.) to 2 lbs. in 50 gallons (0.4 per cent.). Other prewar methods recommended were hand collection on trees, light traps and placing a board (with a key-hole shaped slit in it fitting around the stem) with tanglefoot at the base of the tree which was then jarred so as to entrap the beetles on the sticky board.

II. Postwar.

(A) *Mechanical Control.*

Proposed cultivation of cacao on a large scale soon showed that some kind of physical barrier was necessary to shield very young trees from attacks by *Apogonia*, and it was found that a cylindrical guard of palm fronds rather than primary shade plants (e.g. *Tephrosia* or *Cajanus*) almost invariably led both to an increase in growth of the cacao and also kept out night-flying beetles (2). This method had been used with success on young cacao in Fiji as long ago as 1911 (9), the material employed there being a one inch wide, split bamboo guard to exclude entry by the chafer *Adoretus versutus* Har. which does similar damage in the Pacific as *Chaetadoretus* in Malaya. In Western Samoa a ring of stones is built up around the plants for the same purpose.

The use of easily constructed and renewable guards made from fronds of nipah (*Nipa fruticans*) or *bertam* (*Eugeissona triste*) is recommended when the seedlings are planted out in baskets; after about one year the trees are usually advanced enough not to be set back seriously by *Apogonia* damage and the framework can then be removed.

The sturdiest of these guards seen so far were at Ayer Itam, Penang, where four corner posts had been placed around each cacao tree with four, cut coconut fronds, their butts and tips first removed, suspended from cross bars. This material is normally obtainable in most areas and makes a very good protection.

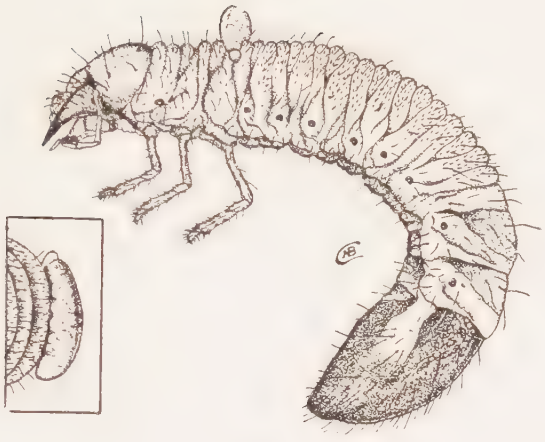
Usually fronds of nipah or *bertam* are used but even tufts of *lalang* (*Imperata arundinacea*) serve to exclude beetles and are easily renewable. Plate IV, Fig. b, shows a perfectly satisfactory shield of this material in use at Sungei Udang, Malacca.

Time spent on constructing sound shields is well worth while as flimsy ones are easily damaged by wind and then require labour spent on renewal or replacement.

(B) *Chemical Control.*

Chafers can be attacked in two ways, either by treatment of the soil to kill developing grubs and sheltering beetles or by spraying or dusting the foliage to kill the latter. In view of the potency of postwar soil

PLATE V



(a)

(b)

(a) *Apogonia* larva showing parasitic grub of *Tiphia* sp. feeding on metathorax of host.

(b) Dissection of hermaphrodite *A.cribricollis* showing in one individual (a) copulatory organ, (b) ejaculatory duct, (c) abdomen (cut), (d) eggs, and (e) intestine.

insecticides it was considered not worth while to proceed with the old calcium cyanamide treatment referred to above but instead to try out the more recently evolved insecticides.

(i) *Soil Treatment.*

As the life history showed, the larval and pupal development together occupy 84 days for *Apogonia* and 100 for *Chaetadoretus* out of a developmental period of 93 and 111 days respectively. As *Apogonia* beetles can live a further two to three months, sheltering each day in the soil near the trees, it is well worth attacking the larval and adult stages during this lengthy period spent underground.

Laboratory tests were made with 5 per cent. DDT and Agrocide 3 dusts, the latter contains 0.65 per cent. gamma BHC ("Gammexane"). Glass containers 1 ft. in diameter holding 14 lbs. of soil were used to which ¼ oz. of the insecticide was added and into which 10 beetles were then introduced with food (canna flowers). This was done four times with the following results:—

Table IV.

Relative Toxicity of Soil Insecticides to *Apogonia* (Laboratory).

Insecticide.	No. of Beetles Dead in Days.							Results
	1	2	3	4	5	6	7	
5 per cent. DDT	0	3	7	7	8	8	10	all dead in 5 to 7 days.
	0	0	0	0	0	10	—	
	0	0	0	0	0	10	—	
	0	0	0	0	10	—	—	
BHC	5	5	—	—	—	—	—	all dead in 2 to 3 days.
	0	10	—	—	—	—	—	
	0	10	—	—	—	—	—	
	0	0	10	—	—	—	—	
Control	0	0	0	0	0	0	0	None dead in 1 week.

Sufficient larvae were not available for replicated tests, but using five larvae with each insecticide it was found that with DDT they were all dead in 22 days compared with only 13 days for BHC. This clearly shows the much more rapid toxicity with BHC than with DDT as a soil insecticide. The residual effect of the latter is, however, well known, but a quick kill was what was required most.

Supplies of Dieldrin (a new chlorinated hydrocarbon containing not less than 85 per cent. of 1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 1a, 5, 6, 7, 8, 8a-octahydro-1, 4, 5, 8-dimethano-naphthalene) were later received and tested in the field for comparison with BHC. At that time there was very little information available as to the rate of its application although the minute quantity of only one to five lbs. per acre was recommended for use against grubs of a European cockchafer, *Amphimallon* sp.

The closely related insecticide Aldrin (containing not less than 95 per cent. 1, 2, 3, 4, 10, 10-hexachloro 1, 4, 4a, 5, 7, 8a-hexahydro-1, 4, 5, 8-dimethano-naphthalene), which has less residual effect than Dieldrin, was also tested. The maker's recommended strength for this was two to four lbs. per acre against another European cockchafer, *Hoplia* sp.

Different concentrations of these two insecticides were compared with BHC by means of soil application under cacao trees. One and a half litres and later one half litre were applied per tree and no phytotoxic symptoms developed. At the end of one month's exposure in the field, samples of soil were collected and tested with ten *Apogonia* beetles per treatment. In the dry weather test (July/August) glass containers with 14 lbs. of soil were used but in the wet weather (January/February) test earthenware pots, each holding about 4 lbs. of soil, were substituted.

Table V.

Toxicity of Soil Insecticide to *Apogonia* One Month After Field Spraying.

Insecticide.	Concentration (percentage active ingredient).	Amount per Tree.	Rainfall.	Mortality of Beetles.
		litres.	ins.	
25% Dieldrin wett. powder	4 gm./litre (0.1 %)	1.5	3.34	30% in 35 days
	10 gm./ „ (0.25%)	0.5	7.99	30% in 21 days
Dieldrex 15 Concentrate (18% Dieldrin)	4 cc/litre (0.07%)	1.5	3.34	20% in 35 days
	5 cc/ „ (0.09%)	0.5	7.99	10% in 21 days
Aldrex 2 (24% Aldrin)	5 cc/litre (0.12%)	0.5	7.99	20% in 21 days
	10 cc/ „ (0.24%)	0.5	7.99	20% in 21 days
BHC (Agrocide wett. powder (6.5% gamma)	5 gm./litre (0.03%)	1.5	3.34	60% in 2 days 100% in 5 days
	5 gm./ „ (0.03%)	0.5	7.99	60% in 2 days 100% in 3 days
Control	—	—	3.34	10% in 21 days
			7.99	0% in 21 days

In the case of the wet weather test the BHC-treated soils, kept moist in the laboratory, were tested again 5½ weeks after spraying and still killed all the insects in three days. Another sample collected in the field 2½ months * after the original spraying was similarly effective; the rainfall here was 22.17 ins. There were no deaths with beetles in untreated soil collected from the same row of trees.

The marked superiority of BHC over all the chemicals tested will be noted. Similar results have been obtained in Canada (8) where BHC was also by far the most effective of all insecticides (including DDT,

* After a further six weeks this soil was still lethal in three days to all beetles tested.

aldrin and dieldrin) when used against both adults and larvae of the June beetles, *Phyllophaga* spp., in meadow and pasture lands.

For local use it is recommended that BHC in the form of a wettable powder at the rate of ½ lb. in 12 gallons of water, using one quart per large tree, should be sprayed on the soil applying it in a circle around the tree; one pint can be used for small trees. These applications can be made when sampling with a trowel shows an average of more than three or four beetles are sheltering at the foot of each tree; these figures are based on the average of 1.2 beetles found under one tree (see Soil Population Studies, page 98). It is emphasised that this method of killing sheltering beetles is supplementary to and not a substitute for the foliage spraying described below; BHC as a dust can be used instead.

(ii) *Foliage Spraying.*

a. *Method of Keeping Seedlings.*

It was soon found that seedlings under any form of close shade, even if only a top shelter of attap, were not attacked by beetles, this even holding good for the unsprayed controls. As young cacao requires to be grown under constant shade it was therefore not possible to use basketed or potted seedlings in the open for insecticide tests. In order to overcome this shade difficulty seedlings were kept in the laboratory and after spraying were given an artificial rain of about half a pint of water per tree every evening for 12 to 14 days. This was applied from a Hydra sprayer and the seedlings were then placed with beetles in rearing cages. Finally it was possible to place seedlings in baskets under a movable roof which was kept over them by day and slid away each evening when there was no danger of sun scorching. This roof, consisting of alternate sections of perspex and corrugated asbestos, was mounted on a steel framework run on rails for easy movement.

b. *Laboratory Insecticide Tests.*

Attempts were made to assess the relative efficiency of the various spray treatments by feeding tests carried out 12 to 14 days after spraying. However, it was found that *Apogonia* and *Chaetadoretus* when presented in confinement with unpalatable foliage refused to eat freely and ultimately died from starvation. With such growing insects as caterpillars and locust hoppers it is easy to record the relative values of insecticides as these insects continue to feed on sprayed foliage and readily succumb.

Tests were first made by placing wire gauze cages 2 ft. high x 1¼ ft. in diameter around sprayed cacao seedlings but only on the unsprayed controls did any feeding occur.

Cut sections of treated leaves measuring 3 x 2 ins. were next placed in petri dishes with ½ in. depth of soil; the cut leaves were removed every three days and freshly cut sections supplied. There was a wide range in mortality of the beetles introduced depending on their contacts with the leaves; the beetles remained in the soil and again did not eat

readily. Finally, small, cylindrical wire gauze cages were used with growing leaves inside and feeding by the beetles was better (Table VI).

It will be understood that under these conditions of poor food acceptability one cannot compare a stomach poison, such as lead arsenate, with the various chlorinated hydrocarbons which are contact as well as stomach poisons; in addition some of them have a fumigant action. It was found that with all treatments *Apogonia* was hardier than *Chaetadoretus* as has already been shown with the starvation tests referred to previously (page 97). With DDT and similar modern insecticides it is known that the toxic effect is primarily through contact with the feet and ventral surfaces of the body, and it is likely that the more waxy covering of *Apogonia* may protect it better than the more delicately-built *Chaetadoretus*.

Table VI.
Survival Times of Chafers Recorded 12 to 14 Days After Spraying.

Insecticide	*Apogonia* Days.	*Chaetadoretus* Days.
Lead arsenate, 0.4%	8—14	6—8
Lead arsenate, 0.4% + 50% DDT, 0.2%	7—13	4—6
50% DDT wettable powder, 0.2% (form 1)	6—9	4—8
50% DDT wettable powder, 0.2% (form 2)	6—8	4—6
BHC wettable powder, 0.5% (6.5% gamma) (0.0325% actual BHC)	7—14	7
25% Dieldrin wettable powder, 2 gm./litre	10—17	6
25% Dieldrin wettable powder, 10 gm./litre	6—10	—
Dieldrin emulsifiable concentrate, 1 cc./litre (0.024% actual Dieldrin)	12—18	—
Dieldrin emulsifiable concentrate, 2 cc./litre (0.048% actual Dieldrin)	10—13	—
Controls. 5 to 10% mortality at end of test periods. (Wire gauze cages used).		Good feeding.

DDT wettable powders gave the quickest kill but the Dieldrin emulsifiable concentrate seems promising at higher rates even at $17 (Straits) per gallon. The Dieldrin became available later than the other insecticides and the wettable powder was sufficient only for laboratory tests.

c. *Field Spraying Test.*

A field test was drawn up early in 1950 in order to gain some information on the relative efficiency of various foliage insecticides to

chafer beetles. This test was laid down at the Rubber Research Institute Experiment Station, Sungei Buloh, and comprised six treatments and one control, each of seven replicates of 40 trees, the 1½ acre block having three interspaces of hedge rubber. The writer had left for the United Kingdom before spraying began: spraying and recording were carried out weekly by Che' Kamardin bin Bahar of the Entomological Division between May and November, 1950. The system of examination was based on the numbers of leaves which were free from beetle injury.

In this test the different types of damage caused by *Apogonia* and by *Chaetadoretus* were not separately recorded.

Table VII.

Relative Leaf Damage Counts—Sungei Buloh.

Insecticide.	Mean Totals of Percentage of Unattacked Leaves.
Lead arsenate, 0.4%	91%, i.e. 9% attacked.
50% DDT wettable powder, 0.2% (0.1% actual DDT)	96%, i.e. 4% „
BHC wettable powder, 0.15% (0.00975% gamma BHC)	88%, i.e. 12% „
Parathion 20% dispersible, 0.025% (0.005% Parathion)	67%, i.e. 33% „
BHC dust, 0.65% gamma	86%, i.e. 14% „
BHC dust, 0.65% gamma + DDT dust, 5%	90%, i.e. 10% „
Control	59%, i.e. 41% „

The concentration of BHC wettable powder as recommended for leaf beetles should have been 0.4 per cent. instead of 0.15 per cent. Toxaphene dust, which had not originally been selected by the writer, caused heavy scorching and was replaced by the BHC dust in May, 1950; it is therefore not given in the results.

The superiority of DDT over lead arsenate is apparent, but with spraying at longer intervals than one week it is reasonable to assume that the arsenate would have been better and confirmation of this came from later tests.

Similarly, BHC with its quick initial action would most probably have been less promising at spraying intervals in excess of two weeks.

The poor results with thiophosphate Parathion will be noted and no further tests were carried out with it or with any true systemic insecticides.

In order to make a further comparison between DDT and lead arsenate, work was begun at the Federal Experiment Station, Serdang,

to try and overcome the inhibiting effect of attap covers to chafers so far as leaf injury was concerned. Forty young basketed seedlings were therefore removed from the nursery and placed in the light shade of mature Manila hemp, where they were sprayed with the insecticides shown below (Table VIII). Four treatments and one control with eight replicates were used and the position of the baskets were randomised in order to avoid two similar treatments being adjacent. Relative leaf injury was to be recorded, two weeks elapsing between each of three sprayings, but no attack developed for six weeks. Results during April and May, 1952, as recorded at two weekly intervals, were as follows:—

Table VIII.

Leaf Damage to Cacao Seedlings Placed Under Shade.

Insecticide.	Injured Leaves per Visit.	Total Leaf Injury.	Average Leaf Injury per Plant.
Lead arsenate, 0.4% -	6, 12, 22	40	5.0
50% DDT wettable powder, 0.1% - (= 0.05% actual DDT)	4, 10, 21	35	4.3
6.5% gamma BHC wettable powder, 0.4% -	16, 20, 40	76	9.5
10% BHC liquid concentrate, 0.1% -	10, 17, 31	58	7.2
Controls -	13, 37, 50	100	12.5

Unfortunately the growth of the plants was so unsatisfactory that they had to be removed to the nursery for watering and the counting was accordingly terminated. However, leaf injuries at three visits showed such a narrow difference between DDT and lead arsenate as to need repetition on older trees. Benzene hexachloride was clearly poorer at the concentrations used.

The only available cacao at Serdang older than seedlings which could be allowed to remain as an unsprayed control for several weeks was a stand of two-year old unselected Trinitario. This plot, of one-sixth of an acre, was growing entirely without shade and was accordingly rather unthrifty, with a good deal of sun-scorch and several dead and dying trees. However, it had fairly heavy injury from *Apogonia* and *Chaetadoretus* and seemed worth using for a spraying test. Accordingly seven rows of trees were marked out in October, 1952, for each of three arsenate and DDT treatments with two guard rows. Spraying was carried out with knapsack sprayers. The actual amounts used were 4 ozs. of lead arsenate and 2 ozs. of 50 per cent. DDT in 6¼ gallons of water.

After three sprayings had been done at fortnightly intervals, counting began on the following system in November, 1952. In 40 trees

from each treatment the number of injured leaves in the four uppermost leaves of the highest shoot were counted (a few trees were too tall for this and the next highest shoots were then selected). It was only possible, however, to make two visits, as when the third one was due the trees were showing such poor leaf formation that it was clearly no longer a record of healthy cacao trees. However, confirmation of the superiority of lead arsenate alone over the mixture with DDT was indicated and is shown in Table IX.

Table IX.
Leaf Counts of Young Cacao Grown Without Shade.

Insecticide.	No. of Leaves Attacked.		Totals.
Lead arsenate, 0.4% -	59/160	70/160	129/320
Lead arsenate, 0.4% + 50% DDT, 0.1% - (0.1% actual DDT)	68/160	67/160	135/320
50% DDT wettable powder, 0.1% - (0.1% actual DDT)	114/160	107/160	221/320
Controls -	123/160	128/160	251/320

If the benefit of the mixture was not manifest over such a short period, it is clearly useless to add DDT as a combination spray. The very severe damage to the DDT treated trees was unexpected and was not observed elsewhere on this scale.

d. *Spray Programme and Recommendations.*

It is perhaps of significance that those countries which, since the war, substituted DDT for lead arsenate for chafer control are all regions of low rainfall judged by Malayan standards. Thus, against the Japanese beetle (*Popillia japonica* Newm.) on the eastern seaboard of the U.S.A. with a rainfall of 40 ins. (New Jersey), DDT was given preference over lead arsenate by the U.S. Bureau of Entomology in 1948. Similarly with the Chinese rose beetle (*Adoretus sinicus* Burm.) in Hawaii, with an average rainfall of 28 ins. and a maximum of 50 ins. (Honolulu), DDT at 0.1 per cent. is recommended, lead arsenate not being even mentioned in a recent publication (16).

On the other hand, in Indonesia another paper (1), published in 1951, showed lead arsenate was better than DDT which in turn was better than benzene hexachloride. This was against *Adoretus* and *Chaetadoretus*, but correspondence with the Institute for Plant Diseases and Pests at Bogor, Java, mentioned similar results there against *Apogonia* on cacao. The annual rainfall at Djakarta is 71 ins. and at Bogor 166 ins. comparing with Kuala Selangor (72 ins.) or Taiping (also 166 ins.).

For controlling chafers on cacao, lead arsenate spray at 0.4 per cent. (1 lb. per 25 gallons) is recommended every four weeks, this interval being shortened in wet weather and during flushes. Although this article is really confined to chafer beetles it is only reasonable to mention that sucking bugs will not be affected by a stomach poison. Hence when cacao trees are old enough to bear pods or have young shoots attacked by *Helopeltis theobromae* Miller, the addition of a 50 per cent. wettable DDT is recommended, the pods and shoots being well covered with the spray.

Although 0.1 per cent. of a 50 per cent. DDT wettable powder is usually used in countries of lower rainfall, it is recommended that 0.2 per cent. be employed in Malaya. This also requires 1 lb. in 25 gallons as DDT in this form has 50 per cent. inactive ingredient. On analysis by the Chemical Division this was found in three formulations to be kaolin or china clay.

In certain very wet regions such as Trengganu with an annual rainfall of 149 ins. (34 ins. in November), it is more a question of getting the insecticide applied when the weather appears to be settled enough for the arsenate to dry on the foliage. In this case a spray of 0.6 per cent. lead arsenate is recommended, i.e. 1½ lbs. in 25 gallons; tests in Kuala Lumpur have shown that cacao flush is not scorched at this concentration.

e. *Stickers for DDT Sprays.*

Attempts were made to see if the addition of various stickers would increase the adhesion of DDT to the foliage. Tapioca flour, which was first heated in a small quantity of water to make a paste, was used first but did not justify itself at the rate of 1 oz. in 3 gallons. Similar results were obtained when dried milk powder (unfit for human consumption) was used at 1½ ozs. in 3 gallons. These tests were made with 0.2 per cent. DDT and did not get beyond the laboratory testing stage as the starch and casein did not improve adherence.

A synthetic sticker called polyethylene polysulphide, which gave good results against caterpillars of codlin moth and fungi on apple trees in New York State, was tested at 0.5 gms. per litre (0.05 per cent.) with the insecticides used earlier (see Table VI) but showed no improvement over the chemicals alone. Only a very small quantity was available and it was found to dry up very quickly, becoming insoluble if not stored in a screw-topped container.

Finally a supply of pre-war whale oil was used at the rate of 7 c.c. per gallon, with the addition of ¼ oz. soap, but again this was no improvement on the insecticides alone and it left an oily film in the hose of the sprayer from which it had to be carefully removed. Although whale oil is now a scarce commodity and unprocurable locally it seemed worth trying this material which is still in use in Canada as an insecticide.

DDT was used only as a wettable powder as this seemed to be the most convenient form. Unpublished information from Java shows that

with 15 per cent. DDT emulsions at 0.2 per cent., application had to be made every seven to 10 days. This would limit its use to seedlings or very small plots.

Summary.

Certain nocturnal beetles do damage to cacao leaves, the main pests being the Melolonthids *Apogonia cribricollis* Burm. and *A.expeditionis* Rits. (the latter having formerly been unrecognised locally as separate) and the Rutelinids *Chactadoretus cribratus* (White) and *Lepadoretus compressus* Weber. Their damage to leaves can be distinguished in the field and is described. Known host plants are listed with a key to all beetle pests on cacao leaves.

The whole life cycle occupies from three to four months of which 10 to 11 weeks are passed as larval white grubs feeding on roots or vegetable detritus. Adults shelter in the soil by day and emerge to feed about half an hour after sunset. Adults of *Apogonia* have been kept alive for two to three months.

A brief soil population count was made and sampling indicated that an average of one insect per square foot, or 43,000 per acre, was reached during one particular month in a field newly planted with cacao. The grubs were more numerous in soil between the trees and the adults beneath them.

An undescribed predatory *Tiphia* wasp has been recorded from the larvae. The unexpected phenomenon of hermaphroditism was revealed by dissection, up to 14 eggs having been found in an individual with a normal copulatory organ.

For checking attack by chafers it is desirable to erect a strong guard of palm fronds or other material until the trees are about one year old.

The best insecticide for killing larvae and adults in the soil was found to be benzene hexachloride at one quart per large tree of a wettable powder (½lb. in 12 gallons of water) applied around the tree. For seedlings, use one pint per tree.

For foliage sprays the best persistent and repellent insecticide tested was lead arsenate at 0.1 per cent. (1 lb. per 25 gallons) ; this to be applied every four weeks, varying with the rainfall and leaf flushes. In very wet weather this may be increased to 0.6 per cent. (1½ lbs. per 25 gallons). Later on as the trees produce pods it will be necessary to add DDT to the spray to control *Helopeltis*. The suggested rate is 1 lb. of a 50 per cent. wettable DDT powder per 25 gallons (0.2 per cent.). Tests with Dieldrin are being carried out:

No sticker was found which when added to DDT made it better than lead arsenate for repelling beetle attack.

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The figures were drawn by the Artist, Mr. Ng Beng Cheng. Credit is due to Mr. Lim Thye Yang for the obliging way in which he typed this draft during a particularly busy period.

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APPENDIX

Apogonia as a Canna Pest.

During this work some observations were made on chafers which feed on the flowers and leaves of ornamental cannas. Besides the common species of *Apogonia* and *Chaetadoretus*, the blossoms are also regularly attacked by *Anomala pallida* F. and *Autoserica* sp.

Gardeners who wish to avoid the white-wash effect following on lead arsenate spraying can use 1 oz. in 3 gallons of water of a 50 per cent. DDT wettable powder (0.1 per cent.). Benzene hexachloride at 1 oz. per 1½ gallons water (0.4 per cent.) is also good but its brown colour is apt to stain the white varieties of canna. It is well known that canna flowers are completely protected by the calyx right up to opening, and as flowers appear every two or three days it is necessary to spray twice or thrice per week in order to get protection from attack.

The following palliative measure will give good results for small beds near one's house; it requires two persons. One person holds an electric torch for shining on the flowers and the other has a six inch diameter metal funnel with a rim, the spout being placed in an empty bottle with a little disinfectant in the bottom. The canna stems are bent, so that the flowers are over the funnel, and tapped, thus dislodging beetles which drop into the bottle; good catches can often be made in this way. It is interesting to note that in Java the cockchafer *Exopholis* is said by Kalshoven * to confine its attack to salmon-coloured flowers, never to canary-yellow or flame-red, but in Malaya red blossoms are preferred to the yellow. Dark-leaved varieties are very lightly attacked, irrespective of their colour.

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* Kalshoven, L.G.E.—1950. "Insects on Canna". Organisation for Scientific Research, Pub. No. 14 (Java).

NOTES ON CURRENT INVESTIGATIONS, JANUARY TO MARCH, 1953.

Compiled by the Acting Chief Research Officer and the Senior Agronomist.

Padi.

General.

Analysis of results from experiments carried out in the 1951-52 season has now been completed. Results from the 1952-53 season are now coming in and analysis of these has commenced.

The wet padi harvest is now complete in Kedah, Negri Sembilan and parts of Malacca and Kelantan and is in progress in most other States and Settlements, although crops are late in Selangor and Province Wellesley. Considerable lodging is reported from Perak and water control on Selangor stations has been disappointing.

Excellent yields are reported from Kedah, Perlis and Negri Sembilan.

Variety Trials and Selection.

Most trials were successful and were reaped by the end of the quarter. Yields have been generally high, pest and disease damage below normal, and there were no instances of non-setting of seed such as occurred last year. Preliminary pure line selections have been completed in foundation stocks of three varieties, Seri Raja (Perak), Kontor (Province Wellesley) and Mayang Sa Gumpal (Kelantan), and material has been collected for the establishment of foundation stocks for selection next season of the varieties Serendah Puteh (Negri Sembilan) and Machang (North Perak).

Hybridisation.

Later maturing plants in the four Cuttack *indica* x *japonica* F_2 progenies proved much more vigorous and fertile than the earlier ones and 400 individual field selections have been made. Some 50 per cent. of the remainder have been discarded on account of sterility.

Of 44 F_2 hybrids of local varieties 30 have been discarded owing to low variability, and numerous selections for high yield, strong straw and early maturity have been made in the remaining 14 families. F_1 plants of a further 61 similar crosses have grown well and yielded heavily.

Manurial Trials.

Results from 50 *bendang* manurial trials in Kedah have just been received: treatments in these trials were as follows:—

A 100 lbs. P_2O_5 as bat guano + 30 lbs. N as sulphate of ammonia.

B 100 lbs. P_2O_5 as C.I. rock phosphate + 30 lbs. N as sulphate of ammonia.

C 50 lbs. P_2O_5 as double superphosphate + 30 lbs. N as sulphate of ammonia.

D control, no fertiliser.

Mean yields are summarized below:—

Treatment	Yield in Lbs. per Acre	
	Medium & Light Soils	Heavy Soils
A	3,131	3,793
B	3,102	3,733
C	3,096	3,856
D	2,770	3,557
S.E.	± 59.618	± 63.995
Mean increment	339.5	237.3

It will be seen that there was a clear response to fertiliser but that differences between type of phosphate were not significant. It is clear, therefore, that the preferred fertiliser dressing will consist of the locally available bat guano with top dressings of sulphate of ammonia.

Costs of the experimental dressings and value of the increments are as follows:—

Cost of fertiliser per acre

A $26.11, B $29.59, C $34.85

Value of increment of padi

	at $15 per picul	at $20 per picul
Medium & light soils	$39.19	$50.59
Heavy soils	$26.70	$35.60

The minimum guaranteed price is $15.00 per picul but the actual roadside price in Kedah (6.4.53) is $20.00 per picul.

Preliminary examination of selected experimental results indicates that good responses have been obtained from fertilisers in the first year of the Negri Sembilan investigations.

At Paya Besar, east Pahang, liming and manuring has led to greatly improved growth of padi but the acreage is limited and bird damage has been severe. Sample plots have been "caged" to give a reliable estimate of yield. The variety Jintan Manis appears to be very resistant to bird damage.

Dry Padi.

Mechanical harvesting by combine harvester has greatly aided the running of Melor Padi Experiment Station, Kelantan, where most of the dry padi investigations are in progress. Reasonably good yields have been reported.

Peat Soils.

A pot experiment with padi on peat treated with and without N.P.K. and/or lime resulted in a good set of grain: N.P.K. + lime gave the best growth and yield, followed by N.P.K. and then by lime alone.

Disease Control.

Growth in hydroponic culture deficient in the major elements shows that lack of potash causes severe stunting, and leaf die-back with dark red spotting. Nitrogen deficiency also produces severe stunting, still more pronounced leaf die-back but no reddening. Both conditions resemble those encountered in certain types of *penyakit merah*. The chief effect of phosphate deficiency is reduction in the number of leaves developed. Application of potash to cases of *penyakit merah* in the field has not so far proved effective, though one case is reported from Kedah of response to sulphate of ammonia.

One case of padi blast (*Piricularia oryzae*) has been reported from Perak.

Pest Control.

Recent investigations lend no support to the suggestion that insect pests are largely concerned in crop failure in the Kuala Sungei Bharu district of Malacca.

An outbreak of Bombay locust (*Patanga succincta* L.) on 800 acres of padi near Raub, Pahang, was not successfully controlled by baiting or dusting, as this could not be carried out simultaneously over the whole area; treatment from the air might well have proved more effective.

Searches up to two miles from foci of liberation of *Paratheresia* have still failed to recover this stem-borer parasite, either in flight or in over 3,000 bored padi stems examined.

Cacao.

General.

Growth of most trials and multiplication blocks at Serdang has been satisfactory. West African Amelonado is now coming away well. The more recent importation of Upper Amazon material is growing very vigorously.

There has been some defoliation of the *Erythrina subumbrans* shade in the budwood nurseries as a result of attack by shoot-borers and Jassids but the trees have now recovered. This attack emphasizes the desirability of using several different species as shade.

Cacao underplanted in a durian variety trial at Selama is said to be growing very well. Bananas and Xanthosoma are also used as shade plants, so results from this trial will be of interest to smallholders.

It is encouraging to note that growth in an important co-operative variety trial on an estate in Negri Sembilan has recently shown a marked improvement after a disappointing start.

From the Federal Experiment Station, Jerangau, it is reported that buddings carried out in wet weather at the beginning of the monsoon gave 32 per cent. failures.

A clonal trial which was planted on an estate in Penang in April, 1952, has shown healthy, vigorous growth of cacao but the *Gliricidia* shade is slow to come away.

Amelonado Propagation.

During the quarter sufficient material for production of some 15,000 plants, including 397 pods, was released. In view of the quantity of pods now forthcoming the production of cuttings has been discontinued.

Trials of "quick dip" methods to improve rooting of cuttings have so far shown these methods to be inferior to the standard method using Seradix B No. 3.

Compatability.

Compatability testing of introduced Trinitario is being continued and 1,000 pollinations on 200 plants have been carried out.

Disease Control.

Pathogenicity tests of *Botryodiplodia theobromae* and species of *Colletotrichum*, *Fusarium* and *Nectriopsis* isolated from rotted pods are being undertaken.

Spraying with p-chlorophenoxyacetic acid and alphanaphthaleneacetic acid produced some decrease in incidence of cherelle wilt; spraying with Bordeaux mixture was ineffective.

Fermate and Zerlate, though preventing basal rotting of cuttings, did not improve rooting percentage. Chlorosis in potted cuttings was cured by leaf injection of 1 per cent. ferrous sulphate, but not by spraying at half this strength.

Pest Control.

Burial of one 2½ gm. Hanane capsule near each of two young trees lightly infested with *Pseudococcus citri* (Risso) resulted in a reduction of infestation within four weeks.

Oil Palm.

Growth in the newly planted variety trial at the Federal Experiment Station, Jerangau, has been very encouraging. All young palms are healthy except for three casualties in a discard row which were damaged by elephants.

An intercultivation experiment at Serdang has been concluded. No significant differences between treatment yields have been recorded and the palms are now overage.

In the replanting and manurial trial, early felling of old palms is of obvious benefit to growth of the underplanted young palms. Nitrogen appears also to encourage growth but there is an indication that it encourages leaf-bronzing.

Dumpy Palms.

Trials newly planted on estates include one to compare thirteen different dumpy progenies, and a second to compare the yield from pedigree dumpy and tall strains. Twenty-eight controlled pollinated bunches have been harvested and over 5,500 seeds and seedlings distributed. 250 acres of dumpy palms planted on four estates in the past year have been inspected and are growing well.

Leaf Analysis.

Chemical analysis of leaves of immature palms of varying ages are being carried out at three month intervals to determine variation in nutrient content under different ecological conditions.

One such investigation is proceeding on five progenies of which three are susceptible to leaf ' bronzing'. These are planted in a replicated layout and in process of treatment with a standard N.P.K. Mg fertiliser with and without calcium. Recent analysis of the third youngest leaf no longer suggests that calcium uptake is greater in the 'bronzed' families, and, though low, magnesium content is similar in all five families. Analysis of the 17th leaf, however, shows a differential magnesium content varying directly with the degree of leaf 'bronzing'.

Pest Control.

Damage to palms by *Oryctes rhinoceros* L. has been reported from several States. In some cases the source of infestation was decaying stumps of poisoned rubber trees, and in another, compost heaps provided breeding grounds; B.H.C. spray was suggested as a palliative in the latter case, though the remedy lies in eliminating conditions suitable for breeding.

Coconut.

An investigational programme for the new Federal Experiment Station at Teluk Bharu in south Perak has been planned and it is now under consideration.

A simple manurial experiment has been designed for impoverished smallholdings on the coast of Trengganu.

Some 50 acres in Trengganu were attacked in March by caterpillars of *Hidari irava* Moore, the skipper butterfly. It is not expected to become serious as the caterpillars are usually heavily parasitised.

Fibres.

Jute.

In a manurial trial at Sungei Burong, Selangor, the mean yield of fibre from the Segama variety was 848 lbs. of dry fibre per acre. A 3½ cwt. per acre dressing of sulphate of ammonia resulted in a significant increase in yield of fibre of 338 lbs. per acre, the actual treatment yield being 1,038 lbs. per acre. When this same variety was grown for seed on mineral soil at the Federal Experiment Station, Kuala Lumpur, the initial growth was excellent but delayed attack by several root nematodes resulted in a very poor seed yield. One of these has been identified as a species of *Meloidogyne.*

Colletotrichum capsici, the cause of stem canker, has now been shown to be seed-borne, but seed may be effectively treated by immersion in 0.1 per cent. mercuric chloride for three to four minutes.

Manila Hemp.

In a variety trial on what is now known to be unsuitable soil at Serdang, the variety Serdang C has out-yielded all others, with Tangongon second. The stem length of Serdang C can be very poor on unsuitable soil but, with manuring, it is now averaging 7 ft. 4 ins. which is considered satisfactory on that particular soil. A new variety trial has now been designed for Degong Agricultural Station, Perak, where both Tangongon and Bangulanon grow very well without manuring.

A variety trial which was planted on muck soil at Sungei Burong in November, 1952, has shown satisfactory establishment with only 10 points failing. Gliricidia wind breaks have been planted and scupper drains have been excavated mechanically.

The cause of stem rot previously referred to as *Marasmius stenophyllus* has recently been obtained in pure culture and identified as *M. subplexifolius;* inoculation and pathogenicity tests are in progress. A field experiment has been commenced to attempt control by copper fungicidal spray or field hygiene. The pathogenicity of a commonly associated fungus, *Poria ravenalae,* is also being tested.

Mauritius Hemp.

An experiment is now being laid down at Serdang in which three types of shade, one being rubber, are being compared with an unshaded treatment. This crop is growing quite well on sandy soils near Besut, Trengganu.

Ramie.

Growth of ramie in two variety trials in Penang and Selangor has been disappointing in the second ratoon and it is now planned to increase the application of fertiliser.

Tea.

During the quarter an average of 40 plants of 30 clones have been planted out in a multiplication area at Serdang.

Rooting trials of 200 clones are in progress and the first count of rooting percentages has been completed. Results have ranged from seven to 67 per cent. successes.

Rooting percentages from trials at Cameron Highlands have been very disappointing and experiments have now been laid down to investigate ways and means of improving results by varying the rooting media and the type of cuttings.

A cuttings-wood nursery of twenty clones has been planted at Serdang with a view to the supply of clonal planting material for use in agronomic investigations.

Uniformity trials for new manurial experiments are in progress at both Serdang and Cameron Highlands.

Copper Treatment.

Preliminary appraisal of made tea indicates that leaf from copper treated bushes is of better quality than that from untreated bushes. Larger samples have been despatched for commercial assessment.

Disease Control.

One outbreak of blister blight (*Exobasidium vexans*) has been reported from the lowlands. Heavy attacks have only appeared in the highlands this season on unsprayed bushes recovering from pruning. An experiment to observe the effect of blister blight on seedling growth has begun.

Pineapple.

Selection.

Growth in the selection plots at Jalan Kebun has continued satisfactorily.

Propagation.

Laboratory tests of propagative methods using dried stem slices, dried crown segments and single crown leaves have proved very successful. The slices and segments gave 100 per cent. success in both peat and loam, young plants being established within 35 days of setting the cuttings. Undried segments and slices were rapidly rotted by fungi and bacteria. Single crown leaves rotted rapidly in peat, but in loam they were still healthy after three months but had not produced young plants.

Peat Soils.

Interim recommendations have been made for the cultivation of pineapples on peat soils. Since these recommendations are subject to modification in the light of results from the experiments now in progress the paper is not to be published, but it has been made available to growers as an information paper issued by the Pineapple Joint Industrial Council.

Pest Control.

An investigation has been commenced to assess the susceptibility of the Sarawak variety to mealy bug damage.

Processing.

Canning research is largely directed towards introducing a greater degree of mechanisation in fruit preparation processes, and stimulation of output and improvement of juice packs. A new 'Segment' pack has been developed and adopted by the industry and first shipments made.

Canning trials of local Sarawak and Smooth Cayenne fruit from young plantings on peat soils have produced disappointing results, but trials are to be continued with fruit of these varieties from other soils. A lightweight container has been designed for air freight trials with fresh fruit of the Mauritius variety.

Pasture and Fodder.

PASTURE.

Axonopus compressus *and* A. affinis *With and Without Shade.*

Further analyses confirm results previously reported and, in addition, both species are now giving a higher yield in the unshaded plots.

FODDERS.

General.

Seven fodder grass experiments are now in progress at Serdang and one is duplicated at Bukit Mertajam, Province Wellesley. Results from these trials are now being examined critically and it is hoped to publish a review shortly. Field observations from these trials reveal that heavy nitrogenous dressings unbalanced with adequate potash and organic matter lead to reduced vigour and an unhealthy, rusty leaf colour.

The very promising new introduction of thornless Mimosa, *Mimosa invisa* var. *inermis* has grown well both in Kedah and Selangor. Thorned rogues did not exceed 0.5 per cent. A feeding and palatability test with pigs caused the death of two animals but the poisonous ingredient has not yet been identified. Analysis failed to reveal any toxic alkaloids but showed that though prussic acid was present its quantity was insufficient to preclude the use of this plant as a green fodder. Even if this crop proves to be of no value as a fodder it has an obviously useful future as a cover crop.

Fodder Grass Analyses.

Sulphate of ammonia applied at two or six monthly intervals gave the highest yield of Guinea grass, but more frequent applications every one or two months gave a higher crude protein content.

On Napier grass (Expt. No. 107) the heaviest fertiliser dressing gave both the highest yield and highest protein content.

An Irrigation and Manurial Experiment.

In an irrigation and manurial experiment Guinea grass yields are still more dependent on fertiliser dressings than on irrigation treatments although this result might well be different in a more seasonal climate.

Vegetables and Food Crops.

A series of variety trials at Cameron Highlands and in Selangor has shown that Japanese or Indian seed of four locally grown vegetables can replace Chinese seed and that yields would be equal or superior to those from standard varieties.

Legumes.

Pure line selection has been resumed in seven bulked selections of soya bean and twenty-two groundnut progenies.

Sweet Potato.

Preliminary assessment indicates that the highest yielders of tops among 65 sweet potato varieties are Kladi, Serangoon No. 3 and Tong King.

Bacterial Wilt of Tomato.

Tomatoes planted after two soil treatments with DD separated by two non-susceptible crops gave double the yield obtained when only one intervening non-susceptible crop was grown. All the plants in the untreated soil of control plots were killed. The bacterium concerned was found by inoculation to be also pathogenic to French bean, groundnut, brinjal and chilli.

Pests.

Survey has shown that onion leaf miner, *Dizygomyza cepae* Hering, has already spread from Singapore to North Johore and there is little possibility now of eradicating it.

Tapioca is recorded as a new host in Malaya of the Noctuid *Prodenia litura* F.

Fertilisers.

The use of ground soya bean and groundnut cakes as a fertiliser has given superior yields of cabbage and superior growth of beetroot to that obtained from a more expensive dressing of prawn dust.

Fruit.

A good crop was harvested in January from the rambutan variety trial at Serdang and all fifteen clones gave good yields. One clone has now been found to be wrongly named, and there are two rogues in a

R.133 plot. Two of the new clones, R.61 and 81, have been found to be of very disappointing quality but this observation will require to be verified elsewhere as certain clones are particular in their growth requirements

Seedlings of Sapucaya nut in a recently-planted multiplication area have grown very poorly in the first six months.

A durian variety trial has been superimposed on an Amelonado cacao seed garden at Degong.

Seedlings of the Chinese gooseberry, *Actinidia chinensis*, have been raised at Cameron Highlands but they show little vigour.

Caterpillars of *Citripestis sagittiferella* (Moore) are recorded as boring fruits of Italian lime.

The Java cacao moth *Acrocercops cramerella* Snell has been recorded on rambutan but has not yet been reported as attacking cacao pods.

Canning Trials.

Papaya. Further canning trials with the "Mexican" papaya have been successful; a small trial is in progress to determine the effect of fruit maturity on quality of the canned product.

Rambutan. In spite of the difficulties of preparing this fruit for canning, trials with un-stoned samples of one of the more acid selections, R.11, showed promise. A storage test for flavour determination will be carried out. Fruit of this variety when fresh is disliked by a large proportion of the Malayan public.

Examination of experimental packs stored since 1949-50 showed promising results with long beans, pomelo, banana (*Pisang Mas*) and soursop.

Miscellaneous Crops.

Derris.

Root samples of twenty-one strains from the Federal Experiment Station, Serdang, and the Agricultural Station, Selama, analysed for rotenone content have revealed several strains from the former station with high quality roots.

Clove.

Some success has been obtained in control of two Cerambycid clove borers, *Niraeus tricolor* Newm. and *Aphrodisium* sp., with Dieldrin, and further tests have been commenced.

Livestock.

Goats.

There have been 25 kids born at Serdang during the quarter but only three were pure-bred. Health has been satisfactory.

In the Bukit Mertajam feeding trial, five half-breds have been slaughtered to-date at a liveweight of 80 lbs. or more. Carcase quality

of these animals has been good from the balanced ration treatment but somewhat too lean when fed on *kampong* rations.

Poultry.

Duck rearing is in progress at five stations in Perak and Selangor. The Aylesbury breed has now been discarded in Selangor because of poor fertility and egg production. Pekins and Khaki Campbells are in good condition but egg production of the former breed is poor.

Miscellaneous.

Soil Surveys.

Preliminary and detailed soil surveys are being carried out in connection with:—possibilities of mixed farming on 2,000 acres in Negri Sembilan; a drainage scheme for a potential padi area at Tanjong Minyak in Malacca; extension of padi cultivation at Batu Rakit in Trengganu where deep peat and *gelam* soils are associated with cultivable clays; and the location of a site for experimentation on mechanical cultivation of padi in connection with the Trans-Perak Irrigation Scheme.

In connection with investigation aimed at amelioration of *gelam* soils, attempt is being made to assess quantitatively the various forms in which sulphur occurs, e.g. elementary, as sulphide or in organic form, as the last type is not directly toxic to plants. Apparatus is being designed to take soil samples without exposure to the air and so prevent oxidation before the soil can be examined.

MECHANISATION .

Half-yearly Progress Report, October, 1952, to March, 1953.

Compiled by the Senior Agronomist.

Recent Importations.

The following new tractor has been received:—

New Fordson Major tractor with diesel engine. In addition the following equipment has been made available by the local agents for test:-

Bombardier Half-Track conversion unit for Ferguson tractor.
Howard Gem Series III rotavator with padi wheels.
Economy tractor.
Nuffield Universal tractor.
David Brown Cropmaster tractor.
Fowler Mk.V.F. tractor.
John Deere Model M.C.1000 tractor.

Tests and Modifications.

Bombardier Half-track Conversion Unit.

This unit has given every satisfaction in tests in padi fields. It is illustrated and discussed elsewhere in this Journal.

These half-tracks have also been used on a Ferguson tractor working on dry peat soil for pineapple cultivation at the new Federal Experiment Station, Jalan Kebun. Under these conditions the performance was very satisfactory but care was taken to check over all retaining-stud nuts at the end of each working day. This precaution is considered necessary with a new unit.

The following description is quoted from the manufacturer's specification:—

> "Each track is composed of two long length rubber belts 3½ ins. wide, ⅝ ins. thick and 15 ft. long, which are joined by cross links 2 ins. wide x 3/16 ins. thick, made of high carbon steel. Studs are bolted to the cross links which protrude up between the treads on the tractor tyre to prevent wheel slippage within the track. The extremities of the belts are joined by a set of couplings which form the tracks. A pressed steel bogie or idler wheel mounted on tapered roller bearings and a 4.50 x 16, four ply pneumatic tyre provide the tension adjustment for the track. The idler wheel assembled on a body spindle pivot or radius arm pivots on needle bearings. This movement compensates for the surface irregularities on which the tractor has to operate. An adjustable tension spring attached between the body spindle pivot arm and a spring bracket mounted beneath the rear axle housing provide the proper ground pressure of the idler wheel. The distance between

the centre of the tractor rear wheel and the centre of the idler wheel is 40 ins. at normal position. The width of the track assembly is 17½ ins., thus allowing a minimum surface area of 1400 square inches for both treads."

Howard Gem Series III Rotavator with Padi Wheels.

This implement is illustrated in Plate I. It consists of a standard rotavator with special large-diameter, steel wheels. It performs moderately well under good conditions but tests have shown that, under average Malayan conditions, the large wheels absorb too much power and the engine stalls very easily. Operation is very difficult indeed, especially when turning, and the machine is considered to be quite unsuitable for use by lightly built Asian operators.

New Fordson Major Diesel-Engined Tractor.

In the absence of suitable direct mounted equipment this tractor has not yet received a full test. However, it has performed well in dry land cultivation pulling a Ransomes Hussar T.D.5A three-furrow disc-plough and a McCormick Deering 19B 8½ ft. cut-away disc-harrow.

Krause 4 and 7 Disc Tillers.

These harrow-ploughs have been tested in Perak. The four-disc model has been used in both swampy and dry land for cultivation to a depth of eight and six ins. respectively. Where weed-growth was thick in swampy ground the discs showed a tendency to ride over the mat without cutting through the cover.

The seven-disc model has been converted into a very promising power-driven Roto-Plough which is described elsewhere in this Journal.

Burch Maize-Cotton Seeder.

This has been tested for drilling maize in Perak. It is a simple machine which can be used for placing fertiliser either to one side or in the rows. It is said to have worked well.

Taki Thresher.

This is a Japanese threshing drum operated by foot-treadle. It has been tested in several places and conflicting reports have been received. At two localities in Perak the threshing rate worked out at 12 gantangs per hour and operation was considered arduous. On the Selangor coast, Chinese padi planters are said to like the machine and to consider its use to be economical.

Tractor-Mounted Threshing Drum.

A simple tractor-mounted threshing drum has been developed at Bukit Merah, Province Wellesley, for mounting on to a Farmall H tractor. It consists of a belt-driven drum enclosed in a wooden box, the threshed

PLATE I

Howard Gem Series III Rotavator with large-diameter padi wheels.

PLATE II

Tractor-mounted threshing drum fitted on to a Farmall H tractor.
Note the wet condition of the padi field.

PLATE III

Closer view of the threshing drum in operation.

PLATE IV

Close-up view of threshing drum and case with hood removed.

padi running through a trap door into baskets placed below this box. Naturally this padi requires winnowing but it is not considered that this is a major disadvantage.

Early trials at Bukit Merah have shown considerable promise with regard to speed, ease of operations and mobility of the unit in padi fields. It is illustrated in Plates II to IV.

Padi Sheaf Transporter.

An interesting development is reported from Talang, Perak, where a Ferguson tractor, fitted with a crane jib carrying a 12 ft. wide hessian bag, has been used to transport harvested padi from field to threshing centre. It was found to be capable of keeping pace with 10 men reaping with sickles.

NOTES ON EXTENSION WORK, JANUARY TO MARCH, 1953.

Compiled by the Chief Field Officer.

Padi.

Seed Distribution.

Reports have now been received from Malacca on the results of the first post-war distribution of selected seed. Ninety "ketua" plots of ¼ acre each were planted and yield records have now been compiled. The average increases in yield from these improved strains have been extremely encouraging, being 23 per cent. compared with sample plots of adjacent unselected seed. It should, however, be noted that these "ketua" plots were laid down on farms which were considered to be the best in their locality.

The 12 seed farms in Malacca have been harvested and have produced a total of 5,020 gantangs of seed. All farms produced satisfactory samples of seed and local planters have been advised to exchange their seed for that produced on these seed farms. The demand for the seed is said to exceed the supply.

It is also reported that six "ketua" plots testing the variety Radin China 17 have been harvested in West Pahang and that considerable interest is being shown in this variety.

Manuring.

The State Agricultural Officer, Kelantan, reports that there is no doubt whatever about the excellent results obtained by smallholders from the use of manure on their padi fields this season, in spite of the fact that a great many of them applied even less than the recommended minimum dressing of 200 lbs. per acre. Bearing in mind the reduced rate of application it seems probable that about 4,000 acres of land were actually manured this season. From the many splendid crops grown, it is clear that in a good season the response is at least as good, if not better, than in a poor season such as last year, and smallholders are most satisfied with the results, which are reported to be showing 30 to 400 per cent. increased crop.

Many smallholders have been conducting their own manurial experiments; they compared results from the use of the commercial manure with other, locally produced materials such as *baja bakar* (burnt soil) and from the use of local manures fortified with addition of some of the mixture. There have been infinite variations in the commercial rates of application, some farmers have applied small dressings to each plant, giving an overall dressing of about 70 lbs. per acre, and even from this reduced application substantial responses have been obtained. The State Agricultural Officer continues to report the interesting feature of the

change in attitude of smallholders to land long abandoned on account of poor yields. Numbers of applications are now being received for alienation of this land, and it is also reported that values of land of poor granite wash soil are rising now that it is known that productivity of such land can be greatly increased.

In general, the season has been one of critical trial by the padi planters in Kelantan with results that have exceeded all their expectations, and great hopes are felt for the future.

Manurial trials are being carried out on growers' land in Kedah, but the results have not yet been analysed. However, the State Agricultural Officer reports that several planters in the vicinity of the padi experiment stations have been sufficiently progressively minded to acquaint themselves with the departmental experimental work on padi manuring and, by using similar methods, they have reported very substantial increases in yield from small dressings of sulphate of ammonia. It is evident that in both Kelantan and Kedah the planters can be said to be becoming 'fertiliser minded.'

The State Agricultural Officer, Kelantan, also reports that work has already started on the intensification of padi production by double cropping of suitable areas, and an attempt is being made to manure and plant about 100 acres in the Salor Irrigation Area with an off-season crop of Taiwan padi. Most of the work will have to be done using mechanical equipment, but if this demonstration of a practice which has been carried out on several occasions on Kota Bharu Experiment Station is as successful in the field as it has been on Departmental land, it will do a great deal towards still further popularising manuring and persuading the padi planters to increase production by double cropping.

Mechanical Cultivation.

From Penang and Province Wellesley it has been reported that a Ferguson tractor owned by the Rural and Industrial Development Authority has been fully occupied working on dry land, and that another tractor with equipment has been ordered. The State Agricultural Officer, Negri Sembilan, reports that two more Ferguson tractors were purchased and they are being run in at the Agricultural Station, Rembau. The new Fordson tractor has been successfully cultivating an area of dry padi land which has been abandoned for some years. This area is expected to be planted with dry padi, maize, and other food crops. From Perak there are reports of the use of tractors for opening up land in new villages and of the normal hire work of the tractors owned by the Rural and Industrial Development Authority. A mechanical thresher has been received for trial and this machine is being operated by a Ferguson tractor.

Rubber.

During the quarter 8,005 yards of budwood and 210,000 clonal seedling stumps were sold to smallholders under the Colonial Development and Welfare Scheme No. 1176. This scheme was closed on the 31st March,

and the financing of improved planting material and all operations in connection with replanting will now be controlled by The Rubber Industry (Replanting) Board.

The main scheme is now being operated and the State Replanting Officers and their staffs are now receiving application forms from those who are applying for the subsidy for replanting. It is evident that the publication of this Replanting Scheme has stimulated considerable interest among smallholders, but it is still too early to report on actual progress in felling old rubber.

Latex Collection.

The State Agricultural Officer, Kedah, reports that total sales of smallholders latex through communal collecting stations amounted to 374,443 lbs. of dry rubber valued at $253,319 net. The Rural and Industrial Development Authority granted the Baling Smallholders Latex Buying Society a loan of $20,000. Although equipment has been bought the water supply has not yet been laid on to the factory, consequently the daily collection of latex continues to be sold to a local estate. Two of the factory staff are undergoing instruction in estate methods at a nearby rubber estate. Two collection centres, one at Sik and the other at Sedan Kerai, with an estimated daily turnover of 8,000 and 6,000 lbs. of latex respectively, are about to be started.

The Rural and Industrial Development Authority sponsored Co-operative Processing Factory at Grisek, Johore, is now completed and is about to be opened. This is one of the most up-to-date and best laid out rubber factories in Malaya.

Fruit.

During the quarter 2,681 budded fruit trees were sold from State and Settlement Agricultural Stations. The State Agricultural Officer, Selangor, reports that new fruit nurseries have been opened on new Agricultural Stations at Setapak and Sungei Bernam. Large numbers of minor fruits such as chempedak, nangka, mangosteen, duku and langsat are being grown in bamboo pots. These may be used for diversification in hedge row planted rubber or for use as shade trees in new villages.

Livestock.

Pigs.

During the quarter 61 Middle White boars and gilts were sold. In continuation of the departmental work in organising the agriculture of the new villages, stud centres for Middle White pigs are being opened and financed or assisted with funds provided by Government. The management of these centres varies, but in general stud boars are provided free and the management is left to the village committee.

Poultry.

2,695 heads of poultry and 3,083 hatching eggs were sold during the quarter. In Selangor, the State Agricultural Officer manages a hat-

chery purchased with a loan from the Rural and Industrial Development Authority; sale of poultry started in December, 1952. The policy is to produce two months old pure-bred chicks inoculated against *Ranikhet* disease for sale at $5.50 each.

General Notes

MALAYAN AGRI-HORTICULTURAL EXHIBITION, 1953.

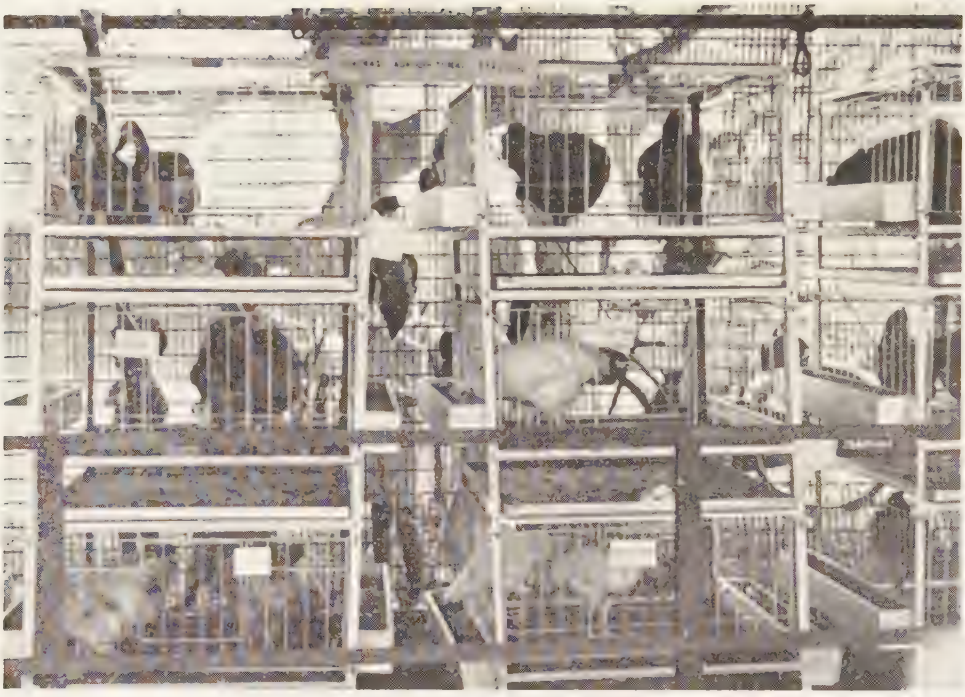
The 21st Malayan Exhibition, organised by the Malayan Agri-Horticultural Association, was held at the Chinese Assembly Hall, Kuala Lumpur, on 10th, 11th and 12th April, 1953. The Show was a small one being mainly confined, on account of the Emergency, to Arts and Crafts. It included, however, a small Flower and Vegetable Show, the latter being arranged by the Agronomy Branch of the Federal Department, and the first exhibition of agricultural machinery. The Selangor Department of Agriculture in co-operation with the Department of Veterinary Services put up a small agricultural exhibit. The Exhibition was opened by His Excellency the High Commissioner, General Sir Gerald Templer, K.C.B., K.B.E., C.M.G., D.S.O., A.D.C., who warned that Malaya could not for ever expect to be able to purchase a large proportion of its food from neighbouring countries. He emphasised the importance of producing more from the land by improving the quality of livestock by breeding and using high yielding strains of crop plants and by widespread instruc tion in the most up-to-date and economical agricultural methods.

The exhibit by the Department of Veterinary Services included a collection of various breeds of imported poultry and stressed the value of Ranikhet inoculation, which they showed to be now popular in Malaya. They also showed cockerels caponised by the new method of chemical implantation. The main object of the exhibit by the State Department of Agriculture was to emphasise the value of the Department in extension work. The first stall showed the planting material and breeding stock available at the new Agricultural Station at Setapak, which is situated 5½ miles out of Kuala Lumpur on the Bentong Road. This Station has been opened to provide extension facilities to Kuala Lumpur and the many new villages around it. During the Show, 526 pure-bred chickens, 52 packages of vegetable seeds and 34 fruit trees were sold. The second stall showed the distribution of the Agricultural Stations in Selangor and the extent to which the Department of Agriculture, in co-operation with the Rural and Industrial Development Authority, is assisting smallholders with such facilities as tractors for hire, stud boars, stud goats, etc. The third stall showed the various soil types in Selangor and their distribution on a soil map together with photographs to illustrate the best types of agriculture for each soil. This logically led on to the exhibit by the State Rubber Replanting Organisation which showed the various methods of replanting rubber and the desirability of diversification and, on certain soils, of changing over from rubber to other crops.

In the three days during which the Exhibition was open some 16,000 people visited the Agricultural Stands.

The proceeds from the Arts and Crafts section are being used to provide prizes for a Padi Show on a State and Federal basis.

The Exhibit shown by the Selangor Department of Agriculture at the Malayan Agri-Horticultural Exhibition, April, 1953.



Poultry from Cheras Agricultural Station, Selangor.

The distribution of Agricultural Stations in Selangor.

Departmental Notes

Promotion.

The Right Honourable the Secretary of State for the Colonies has approved the promotion of Mr. P. A. Gething, Agricultural Officer, to be Senior Agricultural Officer, with effect from the 18th August, 1952.

The Right Honourable the Secretary of State for the Colonies has approved the promotion of Enche Mohamed bin Jamil, Agricultural Assistant, to be an Agricultural Officer on probation, with effect from the 25th September, 1952.

Appointment.

Mr. J. K. Coulter, Chemist (Soils), has been appointed to act as Senior Chemist (Soils) with effect from the 26th January, 1953.

Transfer.

The Right Honourable the Secretary of State for the Colonies has approved the transfer of Mr. R. G. H. Wilshaw, Chief Research Officer, to the post of Chief Registration Officer, Federation of Malaya, with effect from the 14th October, 1952.

Leave.

The following officers have returned from leave:—

Mr. J. K. Coulter, Chemist (Soils), on the 24th January, 1953.

Mr. H. M. James, M.C., Agricultural Officer, on the 5th March, 1953. Mr. James is stationed at the Federal Experiment Station, Serdang.

Statistical

MARKET PRICES

January to March, 1953.

Rubber.—Apart from a short, steady period in February, the Singapore price of No. 1 R.S.S., f.o.b. in bales steadily decreased during the quarter from 93 cents per lb., at the beginning of January to just over 69 cents at the end of March.

As stated above, the price on the 2nd January was 93 cents; it had fallen to 84 cents by the 17th, increased to 86½ on the 20th but dropped again to be 79⅞ cents on the 31st. The average price for January was 85.01 cents per lb.

The price rose to 81 cents on the 2nd February but there was a decline to 76⅝ cents on the 13th. In the second half of the month the price increased slightly until it was 79 on the 27th; the next day it fell to 77⅝ cents. The average price in February was 77.87 cents per lb.

The price continued to decline until it reached 70½ cents on the 16th March, but after some fluctuation it increased to 73⅝ on the 25th, after which the downward trend returned and the price was 69⅛ cents on the last day of the month. The average price in March was 73.35 cents per lb.

The average prices paid for smallholders' rubber at three centres in the Federation of Malaya during the first quarter of 1953 are given in Table I.

Table I.
Average Monthly Prices Paid by Local Dealers for Smallholder's Rubber, January to March, 1953.
(Dollars per picul of 133 1/3 lbs.)

Grades.	Taiping, Perak.			Seremban, Negri Sembilan.			Batu Pahat, Johore.		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Smoked Sheet	92.31	84.90	79.92	91.29	84.98	79.87	—	85.08	82.06
Unsmoked Sheet	73.30	70.68	67.95	66.77	60.64	55.94	70.64	68.88	65.17
Scrap	42.12	43.29	41.16	46.60	42.02	38.98	30.32	31.08	27.74

This Table has been compiled from statistics supplied by the Registrar of Statistics, Federation of Malaya.

Tea.—The most recent average price for Malayan teas quoted in the reports of the Colombo Brokers' Association was Rs. 1.52 per lb.,

for 109,390 lbs. sold on the 12th January, 1953. The average prices of Ceylon teas sold on that day were, in rupees per lb.: High Grown Teas 2.20, Medium Grown Teas 1.79, Low Grown Teas 1.71.

The average prices of Ceylon teas sold on the 23rd March, 1953, were, in rupees per lb.: High Grown 2.18, Medium Grown 1.82, Low Grown 1.71.

Ceylon teas are subject to export duty but non-Ceylon teas sold at auctions ex-bond are not subject to this duty.

In a return published by the Acting Registrar of Statistics, production of made tea in the Federation of Malaya, as declared by estates, during the last quarter of 1952 was given as 898,535 lbs. green and 50,001 lbs. black teas.

Derris.—The average price of this commodity, as quoted in the weekly reports of the Singapore Chamber of Commerce, was between $140 and $150 per picul.

Rice.—The ration is 3½ katis (1 kati = 1 1/3 lbs.) of Government imported and 1½ katis of commercially imported rice per week. The retail prices of rice, which became effective on the 16th March, 1953, are, in cents per kati: High Grade 35 to 41, Medium Grade 27 to 33, Low Grade 19 to 21.

Tobacco.—During the quarter prices, in dollars per picul (133 1/3 lbs.) of cured leaf, have ranged from 350 to 700 for 1st Grade, 250 to 560 for 2nd Grade, and 180 to 300 for 3rd Grade.

Table II.

Singapore Prices of Various Agricultural Products.

(Dollars per picul)

Date	Copra, Sundried	Coconut oil*	Pepper, F.A.Q. Muntok white	Pepper, Gen. Muntok white	Gambier, Cube	Sago Flour, Lingga	Tapioca Flour No. 1	Oilcake, Round
1953								
5th Jan. -	39.50	60.00	525.00	535.00	85.00	17.75	30.00	18.00
12th Jan. -	41.50	64.00	515.00	520.00	83.00	17.75	30.00	18.00
19th Jan. -	42.00	64.00	500.00	510.00	83.00	17.75	29.50	19.00
26th Jan. -	37.50	58.50	530.00	540.00	83.00	17.50	29.50	21.00
2nd Feb. -	37.50	58.50	520.00	530.00	82.00	17.50	29.00	21.00
9th Feb. -	39.25	59.00	535.00	545.00	83.00	16.75	29.00	19.50
18th Feb. -	39.25	59.50	555.00	565.00	83.00	16.50	29.00	20.00
23rd Feb. -	40.25†	61.00	590.00†	600.00	83.00	16.75	28.25	19.00
2nd Mar. -	40.00	61.00	565.00	575.00	78.00	16.50	27.50	19.00
9th Mar. -	41.00	62.00	575.00	585.00	80.00	16.50	27.50	18.00
16th Mar. -	41.50	63.00	605.00	615.00	80.00	16.50	27.50	19.00
23rd Mar. -	42.75	66.00	600.00	610.00	80.00	16.50	27.50	19.00
30th Mar. -	43.50	66.00	600.00	610.00	80.00	16.50	27.50	19.00

* F.O.B. † Nom.

The above prices are taken from the weekly reports of the Singapore Chamber of Commerce.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.
(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1952	1953	1952	1953
January	3,182	3,946	839	1,008
February	3,110	3,611	850	923
March	3,327	3,778	865	1,031
April	3,350		893	
May	3,076		793	
June	3,020		718	
July	3,988		959	
August	3,819		931	
September	4,044		983	
October	4,265		1,066	
November	4,797		1,176	
December	5,117		1,175	
Total	45,095	(11,335)	11,248	(2,962)

In March, 47 estates (planted area 97,778 acres) were in production out of a total of 52 oil palm estates (planted area 100,710 acres).

MALAYAN AGRICULTURAL EXPORTS, OCTOBER-DECEMBER, 1952.

Product	Net Exports in Tons.			
	Year 1951	Year 1952	July-Sept., 1951	July-Sept., 1952
Arecanuts	13,547	10,467	2,858	3,060
Coconuts, fresh † ‡	32,540 †	94,024 †	11,899 †	37,898 †
Coconut oil ‡	68,139	65,113	21,088	22,769
Copra ‡	10,878 *	27,821 *	5,372 *	6,407 *
Copra cake	37,891 *	60,287 *	9,289 *	11,159 *
Gambier, all kinds	36	94 *	2 *	46 *
Palm Kernels	11,809	10,869	3,454	3,105
Palm Oil	45,022	46,008	13,495	12,767
Pineapples, canned	16,859	11,762	2,335	3,161
Rubber ¶	603,880 ¶	582,646 ¶	149,528 ¶	155,434 ¶
Sago,—flour	28,044	19,146	4,789	6,211
„ —pearl	3,401	5,553	1,066	1,472
„ —raw	27,603 *	24,835 *	6,787 *	7,786 *
Tapioca,—flake	462	39 *	115 *	11
„ —flour	4,475 *	4,075 *	1,534 *	1,018 *
„ —pearl	10,230	6,304	2,056	907
Derris	56	13 *	2	2
‡ Copra equivalent	100,499	79,868	29,134	31,350

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Smallholdings (Estimated)		Total	
	1952	1953	1952	1953	1952	1953
January	27,044	31,354	23,770	23,514	50,814	54,868
February	24,007	23,423	19,200	19,140	43,207	42,563
March	25,679	26,898	20,810	16,882	46,489	43,780
April	25,533		19,065		44,598	
May	27,362		18,346		45,708	
June	27,243		20,333		47,576	
July	29,473		20,299		49,772	
August	28,301		22,052		50,353	
September	28,690		20,005		48,695	
October	29,369		18,856		48,225	
November	31,827		18,855		50,682	
December	33,800		22,727		56,527	
Total	338,328	(81,675)	244,318	(59,536)	582,646	(141,211)
Total 1951	327,956		275,924		603,880	

This Table has been compiled from statistics published by the Registrar of Statistics, Federation of Malaya.

Smallholding production is estimated from purchases reported by dealers.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production						Coconut Oil Production		Copra Cake (Poonac) Manufactured	
	Estates		Smallholdings (estimated)		Total		Oil Mills		Oil Mills	
	1952	1953	1952	1953	1952	1953	1952	1953	1952	1953
January	2,740	2,555	9,296	8,241	12,036	10,796	6,681	5,597	4,244	3,594
February	2,777	2,405	8,510	6,092	11,287	8,497	6,338	4,236	4,016	2,694
March	2,864	2,793	8,522	6,703	11,386	9,496	5,616	4,803	3,647	2,983
April	2,964		8,684		11,648		6,128		3,949	
May	3,279		8,560		11,839		5,797		3,820	
June	3,643		7,642		11,285		6,067		3,960	
July	3,846		11,294		15,140		7,177		4,075	
August	4,151		10,357		14,508		7,645		4,902	
September	3,848		12,426		16,274		8,292		5,014	
October	3,358		10,757		14,115		7,622		4,981	
November	3,103		9,569		12,672		7,214		4,695	
December	2,950		9,225		12,175		6,608		4,278	
Total	39,523	(7,753)	114,842	(21,036)	154,365	(28,789)	81,185	(14,636)	51,581	(9,271)

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of smallholding coconut oil production are not available.

4. Smallholding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + smallholding production = exports + local oil mill consumption + estate stocks (closing).

FEDERATION OF MALAYA.

Padi Statistics, 1952-53 Season.

Acreages of Wet Padi Harvested Monthly and Estimated Yields.

State	Total planted area (acres)	Total to 31st March, 1953.			April, 1953.			Total to 30th April, 1953.		
		Area Harvested (acres)	Per cent (3)-(2)	Estimated average Yield per acre (gantangs)	Area Harvested (acres)	Per cent (6)-(2)	Estimated average Yield per acre (gantangs)	Area Harvested (acres)	Per cent (9)-(2)	Estimated average Yield per acre (gantangs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Perlis	48,685[1]	48,082	98.8	450	—	—	—	48,082	98.8	450
Kedah	277,325[2]	268,242	96.7	445	5,293	1.9	206	273,535	98.6	440
Kelantan	145,104[3]	124,755	86.0	272	19,855	13.7	245	144,610	99.7	269
Trengganu	46,282	26,917	58.2	259	16,745	36.1	261	43,662	94.3	260
Penang & P. Wellesley	38,508	33,444	86.8	299	3,970	10.3	138	37,414	97.1	281
Perak	99,733	71,875	72.1	279	25,311	25.3	270	97,186	97.4	277
Selangor	45,693	7,897	17.3	367	13,066	28.6	378	20,963	45.9	374
Pahang	27,778	26,701	96.2	226	620	2.2	212	27,321	98.4	236
Negri Sembilan	28,559[4]	23,060	80.7	312	5,137	18.0	329	28,197	98.7	315
Malacca	26,650	19,705	73.9	316	4,431	16.6	295	24,136	90.5	312
Johore	1,292	836	64.7	221	376	29.1	225	1,212	93.8	222
Total	785,609	651,514	82.9	360	94,804	12.1	273	746,318	95.0	349

[1] 603 acres destroyed by pest, disease and drought.
[2] 3,601 acres destroyed by pest, disease and drought.
[3] 494 acres not harvested due to late planting and damage by pests and disease.
[4] 297 acres failed due to late planting.

FEDERATION OF MALAYA.

Padi Statistics, 1952-53 Season.

Acreages of Dry Padi Harvested Monthly and Estimated Yields.

State	Total planted area (acres)	Total to 31st March, 1953.			April, 1953.			Total to 30th April, 1953.		
		Area Harvested (acres)	Per cent (3)-(2)	Estimated average Yield per acre (gantangs)	Area Harvested (acres)	Per cent (6)-(2)	Estimated average Yield per acre (gantangs)	Area Harvested (acres)	Per cent (9)-(2)	Estimated average Yield per acre (gantangs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Perlis	75	75	100.0	158	—	—	—	75	100.0	158
Kedah	2,697[1]	2,687	99.6	134	—	—	—	2,687	99.6	134
Kelantan	29,000[2]	28,989	99.9	155	—	—	—	28,989	99.9	155
Trengganu	8,531	8,466	99.2	149	65	.8	119	8,531	100.0	149
Penang & P. Wellesley	20	20	100.0	60	—	—	—	20	100.0	60
Perak	1,037	944	91.0	122	93	9.0	100	1,037	100.0	120
Selangor	—	—	—	—	—	—	—	—	—	—
Pahang	2,361[3]	2,285	96.8	156	—	—	—	2,285	96.8	156
Negri Sembilan	10	—	—	—	—	—	—	—	—	—
Malacca	5	—	—	—	—	—	—	—	—	—
Johore	3	—	—	—	—	—	—	—	—	—
Total	43,739	43,466	99.3	151	158	.3	108	43,624	99.6	151

[1] 10 acres destroyed by pests.
[2] 11 acres not harvested due to late planting.
[3] 50 acres destroyed by locusts.

METEOROLOGICAL SUMMARY, MALAYA, DECEMBER, 1952.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
												Amt.								
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak	90.5	70.4	80.5	93.2	65.4	80.0	74.0			4.95	125.7	0.96	14	13	3		1	234.20	7.55	
Port Swettenham, Selangor	88.0	71.2	79.6	91.0	67.6	83.8	73.9	83.6	84.4	7.43	188.7	1.75	19	13	3			205.95	6.64	
Kuala Lumpur, Selangor	89.5	71.6	80.5	92.6	68.4	83.4	74.0			10.35	262.9	1.58	20	17	7	9				
Sitiawan, Perak	88.9	70.9	79.9	91.0	66.0	80.0	74.0	83.5	84.7	4.87	123.7	1.85	12	11	1			230.55	7.44	
Kuala Lipis, Pahang	87.0	70.7	78.9	90.5	66.8	78.0	73.2	82.0	83.5	5.29	134.4	1.65	16	14		25		182.95	5.90	
Kuantan, Pahang	85.6	70.1	77.9	89.7	66.3	81.1	72.7			10.71	272.0	2.39	15	14		1		177.50	5.73	
Temerloh, Pahang	86.5	71.4	78.9	89.5	67.6	81.2	73.3			4.33	110.0	1.98	16	12	2	5		198.35	6.40	
Bayan Lepas, Penang	87.3	73.3	80.3	90.1	68.4	79.5	76.6			3.46	87.9	1.71	6	4				261.80	8.45	
Malacca	86.5	72.4	79.5	91.0	70.4	82.9	74.7			4.88	124.0	1.39	13	11				224.75	7.25	
Mersing, Johore	82.4	72.7	77.5	86.9	67.6	78.4	77.0			12.99	329.9	2.63	18	17				176.05	5.68	
Alor Star, Kedah	88.0	69.4	78.7	91.3	65.9	80.8	73.4			4.52	114.8	3.43	6	5				230.35	7.43	
Kota Bharu, Kelantan	83.5	71.9	77.7	86.9	68.5	73.7	74.8	81.1		20.13	511.3	6.31	20	17				219.40	7.08	
K. Trengganu, Trengganu	82.5	71.9	77.2	84.7	68.8	76.3	76.5			14.25	362.0	2.18	19	16	1	2		207.35	6.69	
Kallang Aerodrome (S'pore)	87.1	73.6	80.3	90.4	69.5	81.3	75.2			7.34	186.4	1.66	18	14	5			173.45	5.59	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	70.4	60.4	65.4	74.9	58.4	65.2	62.4	71.2	71.9	10.62	269.7	3.21	17	16	1	21		139.50	4.50	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	71.2	53.0	62.1	75.0	44.2	65.2	61.2			5.53	140.5	1.44	17	14						

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1953.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										ins.	m m.	ins.						hrs.	hrs.	
Ipoh, Perak	90.8	71.1	80.9	94.8	65.0	85.9	73.4			5.27	133.9	1.48	13	13	2			218.05	7.03	
Port Swettenham, Selangor	88.4	71.3	79.9	92.0	67.1	81.0	73.9	83.8	84.3	7.27	184.7	2.34	12	11	3	3		198.60	6.41	
Kuala Lumpur, Selangor	89.9	72.0	80.9	95.4	68.2	82.9	75.1			5.33	135.4	1.69	13	10	3	9				
Sitiawan, Perak	89.3	71.5	80.4	91.7	67.7	86.4	74.4	84.2	85.0	5.19	131.8	1.96	15	13	1	3		219.10	7.07	
Kuala Lipis, Pahang	84.6	70.4	77.5	90.0	66.2	77.0	73.4	80.3	82.6	7.75	196.8	1.42	20	19		27		132.30	4.27	
Kuantan, Pahang	84.3	71.0	77.7	89.4	66.4	79.0	74.4			21.12	526.4	3.52	23	21	2			132.20	4.26	
Temerloh, Pahang	85.7	71.0	78.3	90.7	66.5	78.1	74.0			4.26	108.2	0.51	22	16	1	7		155.85	5.03	
Bayan Lepas, Penang	88.2	73.8	81.0	90.4	70.1	86.0	76.8			4.46	113.3	1.77	13	9	1			233.90	7.55	
Malacca	86.6	72.4	79.5	90.1	67.7	82.0	74.3			3.61	91.7	1.39	8	6	1		2	210.75	6.80	
Mersing, Johore	82.3	72.7	77.5	87.7	68.6	74.8	76.9			14.64	371.9	2.46	22	21			4	147.05	4.74	
Alor Star, Kedah	89.8	70.6	80.2	93.2	67.0	85.3	74.6			3.61	91.7	1.31	9	9				214.35	6.91	
Kota Bharu, Kelantan	83.7	73.2	78.5	86.1	70.1	78.2	77.8	80.8		22.75	577.9	6.77	22	21	1	1		172.00	5.55	
K. Trengganu, Trengganu	82.4	73.3	77.9	84.6	69.2	78.4	77.3			12.07	306.6	2.41	24	21	1	2		150.85	4.87	
Singapore	86.2	73.6	79.9	90.3	69.0	80.0	76.5			6.78	172.2	0.90	17	15	1		1	157.45	5.08	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	69.4	60.1	64.7	74.3	56.3	64.4	63.0	70.9	71.7	9.75	247.7	1.53	20		1	26	1	121.10	3.91	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	70.8	56.4	63.6	77.0	46.0	65.0	62.0			6.80	154.4	1.21	14					149.85	5.35	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1953.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B. Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day Amt.		Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	m.m.	ins.						hr.	hr.	
Ipoh, Perak	91.3	70.9	81.1	97.2	67.2	85.0	73.0			14.45	367.0	3.60	16	14	5			201.35	7.19	
Port Swettenham, Selangor	88.3	71.2	79.7	92.1	67.1	84.2	74.1	84.1	84.4	15.40	391.2	4.67	21	19	3			175.15	6.25	
Kuala Lumpur, Selangor	89.7	72.0	80.9	93.5	69.6	85.4	76.0			15.59	396.0	3.85	22	21	6	8				
Sitiawan, Perak	88.9	91.6	80.3	92.6	67.3	84.0	74.3	84.2	85.2	6.89	175.0	1.68	17	16	7	2		200.50	7.16	
Kuala Lipis, Pahang	87.0	70.6	78.8	90.0	66.6	82.0	73.6	81.2	82.4	8.69	220.7	2.60	17	17	2	27		156.55	5.59	
Kuantan, Pahang	85.0	70.8	77.9	88.8	67.4	76.6	73.4			14.67	372.6	2.63	22	20		1		125.85	4.49	
Temerloh, Pahang	86.6	71.6	79.1	90.0	66.6	77.5	73.9			7.89	200.4	2.56	18	15	5	12		160.60	5.73	
Bayan Lepas, Penang	88.6	72.9	80.7	91.8	70.6	84.8	75.4			6.47	164.3	1.89	12	10	1			220.80	7.89	
Malacca	86.7	72.5	79.6	91.1	69.3	83.1	74.6			7.27	184.7	2.64	19	18	5		1	199.15	7.11	
Mersing, Johore	82.5	72.2	77.3	85.3	69.9	77.0	77.4			25.28	642.1	5.78	26	24	1		1	139.30	4.97	
Alor Star, Kedah	91.3	70.9	81.1	97.2	67.2	85.0	73.0			14.45	367.0	3.60	16	14	5			201.35	7.19	
Kota Bharu, Kelantan	84.6	72.9	78.7	86.7	70.0	77.7	78.2	82.3		8.94	227.1	3.34	14	11				199.15	7.11	
K. Trengganu, Trengganu	83.4	73.1	78.3	85.2	70.4	78.3	76.9			14.32	363.7	3.42	20	17		4		193.50	6.91	
Singapore	87.1	73.7	80.4	91.5	71.0	80.6	75.8			7.82	198.6	4.20	18	13	6			146.85	5.24	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	70.7	60.3	65.5	75.2	57.9	66.8	62.2	71.4	71.7	11.75	298.5	2.65	23	21	2	13		147.85	5.28	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	71.8	55.8	63.8	76.0	48.0	69.0	62.0			6.80	154.4	1.21	14					149.85	5.35	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, MARCH, 1953.

Locality	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes									Number of days							
	A. Max.	B Min.	Means of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total		Most in a day Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more	Total	Daily Mean	Per cent.
										ins.	mm.	ins.						hrs.	hrs.	
Ipoh, Perak	91.9	72.1	82.0	95.6	67.6	87.4	74.8			15.39	389.1	3.83	15	13	4			228.40	7.37	
Port Swettenham, Selangor	89.3	72.5	80.9	92.6	69.6	85.1	74.3	85.0	84.5	6.23	158.2	1.43	18	14	3			203.00	6.55	
Kuala Lumpur, Selangor	91.0	73.4	82.2	95.0	70.4	86.4	76.0			8.32	211.3	2.96	17	10	2	5				
Sitiawan, Perak	88.8	72.9	80.9	91.4	69.3	86.2	75.0			7.01	178.1	1.18	17	16	7	1		197.50	6.37	
Kuala Lipis, Pahang	89.5	71.7	80.6	93.0	68.7	84.9	74.0	85.1	85.5	2.77	70.4	0.85	14	12	4	24		202.70	6.54	
Kuantan, Pahang	87.7	70.8	79.3	91.3	64.4	82.8	74.8	83.1	83.7	11.88	301.8	4.54	19	8	3	3		188.25	6.07	
Temerloh, Pahang	89.1	72.7	80.9	93.0	69.4	81.4	76.0			3.19	81.0	1.18	12	9	3	10		182.55	5.89	
Bayan Lepas, Penang	88.3	74.0	81.1	91.5	68.6	83.8	76.7			8.13	206.5	2.05	16	15	4			220.20	7.17	
Malacca	88.3	73.6	80.9	92.0	71.8	83.8	76.0			6.78	172.2	0.83	15	14	3			230.10	7.42	
Mersing, Johore	85.2	72.4	78.8	88.4	70.0	81.1	75.5			5.23	132.8	1.44	16	14	1			224.30	7.23	
Alor Star, Kedah	92.0	71.2	81.6	95.0	62.8	85.6	74.7			4.12	104.6	1.51	12	8	1			240.75	7.77	
Kota Bharu, Kelantan	87.5	73.0	80.3	90.7	68.4	84.8	77.9	85.1		4.55	115.6	3.57	10	8		2		271.85	8.77	
K. Trengganu, Trengganu	85.9	72.7	79.3	88.0	69.0	84.0	77.6			5.77	146.6	2.66	12	10		3		262.40	8.46	
Kallang Aerodrome (S'pore)	88.6	74.2	81.4	91.0	72.0	81.6	76.0			10.24	260.1	1.74	16	16	8		2	179.60	5.79	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	72.6	61.9	67.3	75.8	59.9	67.1	63.9	73.0	72.4	12.25	311.2	2.17	20	17	6	21		146.00	4.71	
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	—	55.6	—	—	46.0	—	63.0			9.20	279.4	2.42	19					165.70	5.35	

Compiled from Returns supplied by the Malayan Meteorological Service.